Unasylva

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Equipment News

Unasylva

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Cover photograph by courtesy of Hyster Company, Portland, Oregon, U.S.A. Another view of this logging arch appears in "Equipment News," page 39 of this issue.

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Research

ONE of the functions assigned to FAO by its Constitution is to "collect, analyze, interpret, and disseminate" technical information. The Division of Forestry and Forest Products has been repeatedly requested to make information available concerning current research. The situation with regard to the science and art of forestry shows steady improvement, as was demonstrated at the Third World Forestry Congress held in Finland in 1949. The participants were strongly impressed by the recent progress in all fields of forest and forest products research, and by a striking uniformity of views about the basic objectives to be pursued in the years ahead.

UNASYLVA has approached a number of research organizations and individual research workers for current information. These endeavors will continue and the approach will be widened, in co-operation with the International Union of Forest Research Organizations, so as to make coverage as complete as possible.

A first installment on research is presented in this issue in a series of articles dealing with such basic fields as the function of forests as regulators of water economy, environment and climate, and forest genetics. Basic in an even wider sense is the article on the application of new statistical thinking to all silvicultural research activities.

The Division of Forestry and Forest Products is fully conscious of the shortcomings and of the great difficulties inherent in this approach. However, the interest shown has been so great, and the response of institutions and individual research workers consulted has been so encouraging, that it was decided to present information as it became available, rather than to wait and strive for perfection.

The information available will be presented in two parallel lines: one by short descriptions of projects undertaken, as furnished by the research institutions themselves; the other by analytical articles covering a whole field of research or a specific problem. This double approach, it is hoped, will ensure a comprehensive picture.

UNASYLVA has already presented as a regular feature articles dealing with the organization of research in individual countries.* The series now being initiated deals only with the lines of research being pursued.

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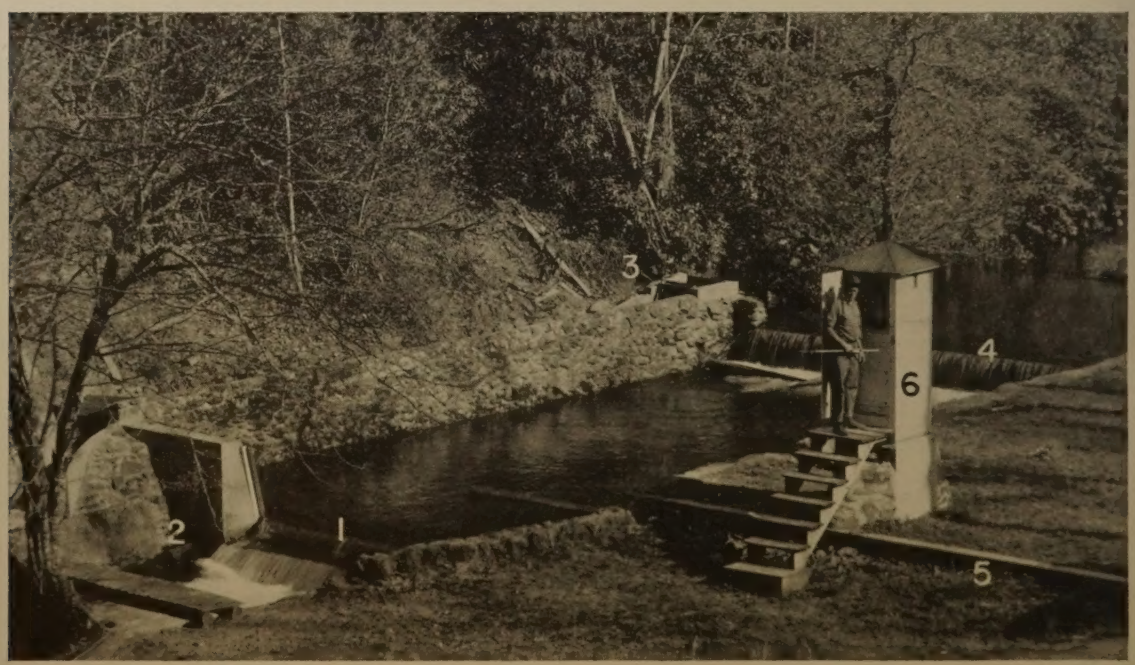
*Australia, *Unasylva* Vol. I, No. 3; Canada, Vol. I, No. 1; Finland, Vol. IV, No. 3; France, Vol. IV, No. 2; India, Vol. IV, No. 3; New Zealand, Vol. III, No. 2; Sweden, Vol. II, No. 5; United Kingdom, Vol. IV, No. 1; United States of America, Vol. II, No. 2.

Above, a calibrated experimental watershed, shown after all tree and shrub vegetation has been cut with minimum disturbance to the forest floor and with no removal of wood products. Sprouts on the watershed have been cut back each year since the original cutting. This is an orientation study to determine the effects of vegetation on stream flow.

Photographs on this page and on pages 7 and 14 appear through the courtesy of the U. S. Forest Service.

Below, stream control showing the following points: 1.—12-ft. Cipolletti weir blade. 2.—Large outlet pipe for draining ponding basin. 3.—By-pass for stream while weir basin is being cleaned. 4.—Level wall to kill stream velocity entering ponding basin. 5.—Emergency cutoff wall extending across mountain valley. 6.—Shelter for 90-day automatic stream recorder operated by a float in a well beneath the shelter. The well is connected by a series of pipes to the ponding basin.



Research in Forest-Streamflow Relations

By C. R. HURSH

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LESS is understood about the management of water than of any other forest resource. Because man cannot alter climate to any great extent and because climate is associated with water, it is a common belief that he can do nothing about managing natural water supplies. This concept is highly erroneous and misleading.

Through his use of the land man can either facilitate the control and storage of rainfall in the soil, or create soil conditions that cause rapid runoff associated with damaging floods and thus waste the water that would otherwise be available for his use. The aim of water resource management is to control and husband the precipitation that falls on the land.

High-yielding streams of superior water quality are universally associated with undisturbed forested land. This is because the soil structure and porosity are favorable to infiltration, maximum storage of water, and control of erosion. Yet this favorable influence of forests on water yield has repeatedly been questioned by hydrologists and water supply engineers on the ground that trees require more water for transpiration than do other plants, thus reducing the total amount of water that will be available on a watershed for stream flow. Obviously, both concepts are reasonable. One of the practical considerations in resolving this paradox is how to maintain favorable soil conditions and at the same time reduce transpiration draft.

Watershed Research

Observational Data Needed

The science of hydrology, dealing with the origin and distribution of water as a natural resource, is still a relatively undeveloped field. The application of the principles of hydrology to the management and use of land is an entirely new field that is scarcely known even to many technicians in forestry and agriculture.

The chief reason, of course, why so little is known about land use-streamflow relations is the lack of experimental data. There are very plausible explanations for this situation. Streamflow studies must be carried out on a drainage area basis, and experimental watersheds are expensive to install and difficult to operate. Many years of continuous, accurate records are required before acceptable results can be obtained. Trained technicians are needed to maintain the necessary recording instruments, and to analyze and interpret the records. Also, the best methods and techniques for watershed research in different climates have not yet been developed or tried out, and much exploration and orientation of the problem will still be required. The same is true in selecting suitable experimental areas that will meet requirements with regard to geology, soils, topography, and rainfall distribution. For these reasons, only a limited number of intensive experimental watershed studies have ever been undertaken throughout the world, notwithstanding the fact that the need for watershed data has long been recognized.

Past Studies

Among the important experiments that have added to the world's knowledge of watershed management, one of the earliest was the Emmen Valley study instituted in 1900 by the Forest Research Institute of Switzerland. In 1909, the Wagon Wheel Gap studies in Colorado, U.S.A., were organized by the U.S. Forest Service in co-operation with the Weather Bureau. Present-day studies to find out the effect of forest vegetation on stream flow are under way in Java and in South Africa.

In the United States of America, watershed studies are being carried out by the U.S. Forest Service in the States of California, Utah, Colorado, Pennsylvania, West Virginia, North Carolina, and elsewhere. The Soil Conservation Service has developed an intensive watershed research area at Coshocton, Ohio, and has conducted watershed studies in other sections to find

out the effect of soil erosion control practices on farm land. A number of engineering schools have also used experimental watersheds to obtain runoff formulae for use in the design of storm sewers, culverts, and bridges. Much general information has been gained from these experiments as to the basic requirements for studying land use effects on stream flow. They also indicate that certain physiographic regions are more favorable than others for studying fundamental hydrologic processes.

The Coweeta Hydrologic Laboratory

Requirements and Selection

To evaluate the hydrologic principles basic to practical watershed management in the high rainfall belt of the Southern Appalachian Mountains, a watershed laboratory site was located in the southeastern United States by the U.S. Forest Service in 1931. The selection of this field laboratory was made only after careful research to find an area that would meet rigid specifications designated by hydrologists, engineers, and foresters interested in watershed research. In 1933, intensive water resource management research was begun at this 5600-acre* Coweeta Hydrologic Laboratory in western North Carolina.

Lying at elevations of 2,200-5,200 feet, the topography of the Coweeta Laboratory is particularly suited to the experimental study of small drainage basins that meet all requirements of independent hydrologic units. Slopes are steep, and sharp-crested ridges form natural boundaries for the many small watersheds ranging in size from 25 to 200 acres.

The entire area is underlain with deeply weathered Archean granite formations, principally of schist and gneiss. There is no indication of any quantity of seepage escaping measurement. The soils are relatively deep and porous. Rainfall averages about 72 inches (1,830 mm.) per year and is fairly evenly distributed throughout all the months of the year. Because of this pattern of precipitation and the large number of storms per year, it is possible to obtain experimental results in a relatively few years, as compared with regions having less rainfall.

The entire area has been little influenced by land use occupancy. A dense mixed hardwood forest is dominant, with scattered pines on old fields or occasionally on the ridges. Some scattered hemlock is found along the streams. Although about 60 percent of the area had been cut over a quarter century or more before the federal government acquired ownership, this part of the Coweeta now supports a second-growth forest, with the remainder still in old growth. Before being killed out by the blight, chestnut (*Castanea dentata*) was the major species. Now about 80 percent of the Experimental Forest supports oak-hickory stands. Fifteen percent is in cove hardwoods: yellow poplar (*Liriodendron tulipifera*) and northern red oak (*Quercus borealis*). Hemlock (*Tsuga caroliniana*) occurs with this type along the streams. Five percent is in northern hardwoods: sugar maple (*Acer saccharum*); yellow birch (*Betula lutea*); beech (*Fagus grandifolia*). Pitch pine (*Pinus rigida*) is also among this five percent but occurs only at lower elevations.

The forest is three-storied: large trees form an upper layer, small trees and large shrubs the second, and shrubs or herbs cover the ground. The dense understory of laurel (*Kalmia latifolia*) and rhododendron (*Rhododendron maxima*), present on some slopes, may be the result of fires during the last century.

Scope and Objectives

The long-range plan of research for the Coweeta Laboratory is directed toward four related fields:

1. To establish fundamental forest and water relations.
2. To furnish coefficients of runoff, infiltration, and water storage for different types of land use such as grazing, logging, and "mountain farming."
3. To develop principles for silvicultural management that will provide for maximum supplies of usable water of highest quality.
4. To work out feasible and practical methods of stabilizing the soil in logging operations, on road banks, and along streams and reservoir shore lines.

Technics and Methods

At present, the water behavior of 28 watersheds is being studied. Of these, 16 are now or are to be treated experimentally, and 12 are held as control units and for future experimentation.

Different types of stream-gaging controls are required for different size watersheds, to measure runoff accurately over a wide range from low flow and the maximum storm discharges. Each stream control is designed to meet the specific requirements of the experiment. Sharp-crested notched weirs, blades with a 45-degree down-stream bevel, are used for most small watersheds of less than 100 acres. Rectangular and Cipolleti blades of several sizes are used for larger drainages. Where the most extreme range between minimum and maximum flow occurs, a deep-notched ogee cross-section cement weir is used. This weir is thought to have the added advantage that it will pass sediment and rock debris without clogging the notch.

The behavior of ground water is being studied by means of 26 observation wells in which movements of the water table are recorded by automatic instruments.

Precipitation is measured at 75 rain gage stations after each significant storm. These stations have been located with regard to aspect and elevation in such a manner that no two adjacent stations will differ from each other by more than a 5-percent catch. Ten rainfall intensity recording instruments are also maintained. Total rainfall distribution over any one watershed is estimated on the basis of the Theissen-mean area method. This method calls for accurately locating each rain station on a carefully drawn map. Polygons formed by perpendicular bisectors of lines connecting adjacent stations circumscribe the watershed area best represented by the single station enclosed.

Calibration of Watersheds

The over-all research program followed for the Coweeta Hydrologic Laboratory called first for taking continuous hydrologic measurements of all the major

*Conversions: 1 inch = 2.54 cm.; 1 foot = 0.3048 m.; 1 sq. mile = 2.59 km^2; 1 acre = 0.4047 ha.

watersheds and their tributaries for a period of five to ten years under the natural forest cover. This was considered to be a period of calibration and standardization during which the streamflow characteristics of each watershed are established. Changes in the vegetative cover are then carried out under carefully controlled experimental procedures, while the records of runoff and rainfall are continued in the same manner as before. Uninterrupted records of the continuous water economy of the experimental watershed are maintained both before and after changes are made in the vegetation cover. The effects of changes on the watershed can then be statistically compared in terms of storm hydrograph characteristics or in terms of changes in monthly yield and water quality. Annual climatological differences are adjusted for by maintaining one or more control watersheds under natural conditions permanently, to be used as reference check areas.

On the average, about 50 significant storm hydrographs suitable for detailed analysis were obtained each year. Furthermore, the pattern of seasonal yield by months soon fell into a rather uniform pattern on the basis of only a few years' records.

As the Coweeta projects developed, it was found that due to particularly favorable rainfall, soil, and topographic conditions for watershed studies, the solution of certain fundamental problems of stream behavior on forest land was possible even before the period of watershed calibration had been completed.

Normal Characteristics of Stream Flow Under Natural Forest Conditions

During the period of calibration it was found that in short intense storm periods streams rose rapidly—almost as rapidly as streams from relatively impervious, non-forested watersheds. This phenomenon in the past has been interpreted as indicating that there is inadequate infiltration of rainfall into forest soil and that overland storm flow does take place, despite claims to the contrary, from the soil of heavily forested hardwood areas. Observations in the field, however, during such storms on the Coweeta watersheds indicated that there was no accumulation of storm water at any place on the watershed, and consequently there could have been no overland storm runoff.

Further investigation showed that these rapid rises in streams from forested areas are due almost entirely to rain that falls directly into the stream channel, and are not due to lack of infiltration into the forest soil. By establishing the exact contribution of channel precipitation to runoff on a watershed basis, it then became possible to separate out this component of the storm hydrograph for further analysis and interpretation of stream flow as it relates to watershed conditions.

Interpretation of Forest Hydrographs

A similar analysis was made of the storm hydrograph from forested areas during periods of long-continued rains. In this case the storm hydrograph shows a considerable increase in stream flow that obviously cannot be accounted for as channel precipitation alone. Neither can it be assigned to overland storm runoff caused by lack of infiltration into the soil. On the Coweeta watersheds an analysis of the movement of shallow water tables as recorded in observation wells showed that rainfall first entered the soil and then moved laterally through the porous upper soil layers to the stream channels in time to contribute to the storm hydrograph. Thus it was shown that the storm runoff hydrograph was produced both by channel precipitation and a form of subsurface flow, the nature of which had not, until then, been explained clearly. This latter type of storm runoff is intermediate between overland storm flow and ground water seepage, and has been called subsurface storm flow. It is an important factor in runoff from forest land and takes place only where the surface soil is extremely porous and has many large openings due to decaying roots, earthworms, or insect and rodent burrows. Also, a portion of this flow probably moves through old drainage lines in buried ravine fills. Thus the storage of large amounts of rainfall by the porous forest soil mantle is analogous to the regulation of storm water by conservation-detention dams which impound only the water that would be in excess of the stream channel carrying capacity. For Coweeta this detention storage is estimated at about 7 million cubic feet per square mile (77,000 m^3 per km^2).

Annual Water Balance

Still another study relative to normal stream flow under control of natural forests relates to the annual balanced water economy of small watersheds. It was found that for the humid Coweeta climate, the precipitation recharge for any one year can be accounted for in measured terms of runoff, soil moisture, ground water stored on the watershed, evaporation, and transpiration. The water balance of outflow and inflow is expressed by the expanded equation: precipitation equals runoff, plus or minus free ground water in storage on the watershed, minus evaporation, minus transpiration, plus or minus current field moisture retention.[1] Balances so far have been made on the basis of monthly invoices, but it is recognized that for certain purposes water accounts should be kept storm by storm, and this will be the ultimate objective of the study.

Ordinarily the water year is based on a 12-month period, starting the first of October or November. Past studies have shown it to be difficult to strike a water balance on this basis. The time period most favorable for striking such a balance had been anticipated on theoretical grounds as being the spring, but experimental proof was lacking because accurate, continuous records from suitable small watersheds were not available. An analysis of Coweeta records showed that the approximate 12-month period between two spring dates of maximum field moisture storage does furnish the most favorable interval for making the annual water balance. At this time the soil is at field capacity and the factor of field moisture, which is difficult to measure on a watershed basis, is eliminated from the primary equation of inflow = outflow ± storage.

Measurements were also made to find out the

[1]This is made up of the capillary film of water surrounding soil particles and is retained against the force of gravity. Consequently, it does not contribute to stream flow, although a portion of it can be used by plants.

amount of rainfall that is lost to the forest floor because of interception by tree canopies. When corrected for the amount of rain that reaches the forest floor by flowing down the tree stems, this was found to be from 12 to 18 percent of the total annual rainfall.

These studies carried out on natural forest watersheds during the period of calibration provided a sounder basis for evaluating the effects of watershed treatments subsequently carried out at Coweeta.

Effect on Stream Flow of Cutting Forest Vegetation

Forest vegetation creates a porous soil which admits and stores large quantities of water, but at the same time the trees use considerable water in their growth. These two facts have caused a great deal of speculation as to the role of forests in the regulation of stream flow. Some authorities have advocated the clearing of forests to increase water yield by eliminating transpiration, while others have maintained that to remove the forest would lead to immediate disaster. Water would rush off over the soil surface as a flood, leaving little to be stored underground for sustaining dry-weather flow. There is some truth in both these extremes, and the job of the watershed manager is to reach an effective compromise between them. In areas where maximum yields of water are important, the task is to reduce the forest stand enough to minimize transpiration but to leave enough trees to perpetuate a favorable forest soil. On the other hand, where the need is to provide maximum storage in the soil for rains that may otherwise produce floods, it would be more desirable to encourage dense vegetation that will draw heavily on soil moisture.

Because of the limited number of standardized watersheds available, regional importance of specific problems has established the priority of treatments carried out at the Coweeta Laboratory. The following watershed problems were agreed upon by representative land administrators and research directors of the region:

1. Effect on stream flow of cutting forest vegetation.
   a. Complete removal of all major trees and shrubs, followed by annual sprout-cutting of all woody plants.
   b. Complete removal of all trees and shrubs, followed by natural regrowth.
   c. Effect of cutting only stream bank vegetation.
   d. Effect of cutting dense rhododendron and laurel understory only.

Effect of Cutting and Subsequent Annual Removal of Sprouts

This experiment was designed as an orientation study to find out what would be the maximum effect on streamflow yields of cutting all forest vegetation. After the period of calibration, all tree and shrub growth was cut on one watershed of 33 acres. The cutting was done with a minimum disturbance to the soil. The logs and slashings were all left on the ground in order not to disturb the surface. Because of the large amount of cut plant material lying on the ground, evaporation from the soil and from the tree branches remained about the same as before cutting. The first summer after cutting, every sprout was slashed back, and this sprouting was continued each successive year. The effect on water yield was spectacular. Although there was no increase in storm peaks or stream turbidity, the yield of high quality water increased 65 percent in terms of annual runoff, during the first year after cutting. This is equivalent to a volume of water 17 inches deep over the 33-acre watershed, or approximately 15 million gallons. From one square mile of watershed this increase would be enough to supply a town of about 8,000 people for one year. During the later summer months when water is most valuable, the increase in usable base flow of the stream amounted to 100 percent.

This experiment will be continued by cutting back all annual regrowth until more has been learned about changes that take place in the soil under the present ground cover of herbaceous species, low briars, and vines that have invaded the area. The original additions of slashings and logs naturally increased the amount of organic material on the soil surface at first, but after ten years it is rapidly disappearing. The problem now is whether it will be possible to maintain a soil under the present plant cover that has the same infiltration and storage for rainfall as the original forest soil possessed.

Effect of Cutting and Natural Regrowth

On another watershed of 40 acres a quite similar cutting was carried out, but in this case the forest was allowed to come back through sprouting and natural regrowth. The increased water yield the first year after cutting was the same as in the above experiment, but subsequently there was an increase in transpiration each year and a relative decrease in water yield. Aften nine years of regrowth the forest is about 30 feet high, but the increase in yield for the watershed still amounts to about 25 percent annually.

Effect of Cutting Riparian Vegetation

On still another watershed only the trees and shrubs close to the stream channel and its associated high water tables were cut and slashed to the ground. The cut was confined to woody vegetation within 15 vertical feet of the streambed. This was all done during the course of a few days in midsummer, at a time when the stream flow was exhibiting a very definite diurnal fluctuation. The cutting eliminated this fluctuation—indicating that it had been caused by transpiration draft. About 12 percent of the total area of the watershed was cut. The maximum daily increase in yield was about 20 percent. The annual increase was less than 10 percent.

Effect of Cutting Ericaceous Understory

A dense understory of *Kalmia latifolia* and *Rhododendron maxima* is frequently associated with mountain hardwood stands. This understory is often 10 to 20 feet (3 to 6 m.) tall and is made up of stems that

Method used for establishing a cross-section of road to determine erosion losses. This road lost 2 cubic yards per lineal yard of road through erosion during the period of one logging operation.

will sometimes reach a diameter of 9 inches (23 cm.) at breast height. The foliage is evergreen and waxy on the surface. It is believed, however, that these plants transpire considerable quantities of water throughout all seasons of the year. Consequently, in making orientation studies of the amount of water used by different types of vegetation, a watershed experiment was carried out in which a dense understory of *Kalmia latifolia* and *Rhododendron maxima* was completely cut to the ground over a drainage of 70 acres. The results show a change in water yield, but the magnitude of this change has not yet been ascertained.

Changes in Stream Flow Through Land Use

Although the preservation of an undisturbed forest cover is probably the best possible watershed management practice for flood reduction and erosion control, all land cannot remain in forest. Naturally, in semi-humid and humid regions land must be cleared of forest growth for cultivated crops and improved pasture. The problem becomes one of how to use the land and at the same time maintain a soil structure that will favor infiltration and water storage. The problem of watershed management is to aim at maintaining a soil structure that resembles as nearly as possible the soil under the original natural forest. This is not a simple problem. For the most part, the clearing of level land has not created important watershed problems. But the clearing and use of steep land for crops, done largely on a trial and error basis, has created many problems and given rise to wide differences of opinions as to how such land can be safely cultivated. Also, there have been conflicting ideas as to the degree of damage done by woodland grazing, logging, and road construction. The effects of these practices on water yield and quality have been investigated on an experimental watershed basis at Coweeta.

Effect of Steep-Land Farming

Although many millions of acres of steep forest lands have been cleared and used for crops and pastures, there is very little precise experimental data on how stream flow is affected by this type of land use. To find out the effects of one very extensive type of mountain farming, a 23-acre Coweeta watershed was first calibrated under forest for a period of seven years. The forest was then cleared away in 1940, and the land area has since been maintained as a mountain farm. The farming methods were those followed on similar land in the locality of the Coweeta Laboratory. About one-third of the watershed was cultivated in maize and the remainder was kept as an unimproved pasture. Half the pasture was so steep it was used very little by the cattle and grew back rapidly in trees and shrubs. During the first two years of cultivation there was practically no change in the amount of storm runoff from the watershed, and soil losses were practically the same as before clearing. These results were surprising to many persons who had contended that removal of the forest on such steep land would induce landslides and erosion with the first heavy rain. The reason why erosion did not take place was simply that the loose friable forest soil structure which characterized original forest conditions remained unchanged for the first two years, although all the trees had been cleared away. However, beginning with the third year, the soil aggregates be-

gan to break down into single grains as the organic material disappeared. The surface began to be sealed over, infiltration and storage were reduced, and storm water began to accumulate and run down the steep slopes. Accelerated erosion has progressively increased since the third year after clearing.

When the watershed was in forest cover, the sediment carried by the stream was insignificant. For the period of 4 May to 8 September, 1943, four years after clearing, the sediment measured in the catchment basin averaged 768 pounds per day. During one storm in 1949, 152,000 pounds (69,000 kg.) of soil and rocks came off this mountain farm in 65 minutes of storm flow.

Maximum flood peaks for average storms increased about ten times after this watershed had been converted to a mountain farm. Before clearing, the storm peak was less than 30 cubic feet per second per square mile (0.33 m^3 per second per km^2), even for severe storms. The maximum was about 100 c.s.m. (1.1 $m^3/sec/km^2$) for exceptionally intense rains. After eight years of use as a farm, storm peaks of 200-300 c.s.m. (2.2-3.3 $m^3/sec/km^2$) are of common occurrence and the maximum recorded peak for a severe storm is 1,850 c.s.m. (20.2 $m^3/sec/km^2$). Today the heavily trampled pasture portion of the pasture land is the principal source of surface storm runoff. Although making up only 20 percent of the watershed, this trampled pasture produces 60 percent of the storm runoff. It is apparent that the trampling by cattle reduced infiltration of rainfall more than maize cultivation did. Surface storm flow from this portion reaches the stream ahead of the runoff from the cultivated land and so produces a double peak in the storm hydrograph. Obviously, the clearing and cultivation of steep land as it was carried out on this watershed has been definitely unfavorable to water quality and to water control.

The results are generally applicable to average and poor farming practices in other areas of similar topography and soils. A better type of farming would call for rotating the corn with clover and small grains, and the regular use of more fertilizer. On the pasture, fencing and rotation grazing of a more restricted number of cattle per acre would result in less trampling damage. However, it is often pointed out by visitors that more intensive farming practices would be difficult and perhaps unprofitable on such steep land, and the private owner would be better off to allow such areas to remain in forest.

Effect of Woodland Grazing

At one time livestock on forest land produced the principal sources of cash income in the mountains adjacent to the Coweeta Hydrologic Laboratory. Widespread burning was practiced to reduce the density of the forest cover and favor the development of grass and sprouts. The advent of fence laws, elimination of fires, and decreased economic returns have reduced the importance of open ranging in the mountain hardwood forests. Today, however, grazing of small farm woodlands is still a very common practice. In fact, farm programs encourage more livestock, and although the trend is toward establishing improved pastures on good soil, the aggregate of grazed woodland is still considerable, occupying 20 percent of the land area in this county.

To find out the effects of farm woodland grazing on stream flow, an average of eight head of cattle were kept on a 145-acre watershed during the summer months for nine years. For this study it was necessary to definitely overtrample and overgraze the watershed in a manner comparable to the typical use of other farm woodlands in the locality.

The cattle were inclined to concentrate on the rich cove soils where the browse was most palatable. Comparisons of vegetation changes are made of 17 fenced plots and 17 unfenced plots. After seven years of grazing, all legumes have completely disappeared on all the grazed plots. The reproduction of the most desirable tree species has been eliminated in all the browsable range of plants from 3 inches to 15 feet (8 cm. to 4.6 m.) in height on the cove area. One hundred percent increase took place in the number of woody shrubs not palatable to cattle. After the first two seasons, the cattle were unable to maintain themselves on the browse remaining, and would have starved but for supplemental rations.

Although no observable changes took place in stream flow or stream turbidity during the first eight years of this experiment, there was from the start an obvious trampling effect and destruction of the forest litter wherever the cattle concentrated. It was not until after eight years of summer grazing that significant changes in runoff were discernible. The reason is that the forest litter collected in small ravines and depressions as it was blown by the wind from the sheet-eroded trampled areas. This litter filtered out the silt, enabling clear water to go into the soil before it reached the main watercourse. As the sheet-eroding and trampled areas increased in size, there was a gradual increase in the amount of storm water accumulation on the soil surface. As the amount of surface storm water increased, it finally gained sufficient force to carry away the litter plugs along natural drainage lines and develop uninterrupted drainage channels to the main stream. At the end of the eighth grazing season there existed for the first time an uninterrupted channel from the storm runoff source areas to the permanent stream channel. At once there was a sharp upturn in the amount of sediment carried and in the magnitude of the peaks in the stream hydrograph.

This experiment, though it purposely brought about overtrampling of the farm woodlands, showed the nature of gradual soil compaction and its significance in water control. In the early stages, trampling damage to the watershed may easily be overlooked. The insiduous accumulative effects were not conspicuous until they became of sufficient magnitude to create extremely unfavorable watershed conditions. Further studies would be required to find out the number of cow days of grazing per season that would be possible on this watershed without serious damage to water values. Although the Coweeta studies are too limited to permit sweeping conclusions, the results point to the fact that there is insufficient herbaceous forage at best in dense hardwood stands to make very profitable grazing. Also, it is apparent that cattle damage the young growth of desirable tree species and thus reduce the quality composition of the stand. Where watershed values are at stake, there appears to be every reason for the complete elimination of grazing from hardwood stands.

Effects of Logging

In the United States of America the present tendency in mountain logging is to reduce the amount of ground skidding by taking the hauling trucks to the job. As a result more and more woods roads are being pushed directly to the timber operation by bulldozers, without the usual careful planning given to most road construction. The truck trails are not well located or built to provide for adequate drainage. As a result, active erosion takes place, and considerable sediment is carried into the streams.

At the Coweeta Hydrologic Laboratory a 212-acre watershed was cut and logged by a local contractor using the usual methods with which he was most familiar. At first, logs were skidded down the natural drainage channels by horses, in keeping with common logging practices. Later a 2.3-mile truck road was bulldozed in to the operation in a location chosen by the contractor.

The effects of logging were soon perceptible in deteriorated water quality. During logging the stream flow carried an average turbidity of 95 parts per million, compared with 4 parts per million for an uncut control unit. Flow from the logged area ran as high as 6,000 parts per million during the most intensive storms, in contrast to a maximum of 120 parts per million for the control unit.

Before logging, sediment carried by the streams was largely organic material that settled out rapidly and was not damaging to the fish habitat. In contrast, the finely divided silt and clay particles carried in the stream after logging had a very low settling rate, and such sediment can be removed only by costly filtration. This type of sediment is also very injurious to game-fish habitat tending to smother fish eggs and alter feeding conditions at the stream bottom.

Not only was water quality from the 212-acre logged area seriously impaired, but all the water from an 1,880-acre drainage basin into which this small tributary flowed was also damaged. Formerly, the larger stream had run clear; during and after the logging job it would have required filtration for municipal and industrial use. During one storm, the main clear stream had a turbidity of 25 parts per million above the entrance of the logged tributary stream, which was carrying a turbidity of 1,200 p.p.m. Below, with a total drainage of 1,880 acres, the main stream carried a turbidity of 395 p.p.m.

Assuming that the water from the 1,880-acre area were to be processed for domestic use and that a filtration plant were available, the total returns of $2,208 for selling wood products on the 212 acres logged would carry the increased processing costs for only a 490-day period, or 20 percent of the time that active logging was under way.

These results bear out observations in other parts of the country, that logging is a primary cause of erosion and sedimentation of forested mountain streams. Operators most familiar with the problem now believe that the efficient planning of a logging job, better road location, better construction and drainage, and better road maintenance will result in savings of time and equipment to the operator as well as in reduction or elimination of filtration costs to water users. Observations to date indicate that efficient logging practices including road construction will meet the essential requirements for the protection of watershed values during timber operations.

Discussion

Experimental watershed studies provide basic data that will lead to a better understanding of the ways in which forests function in the control of water and the conservation of water resources. A knowledge of these functions is necessary in order that foresters and land managers may effectively discharge their responsibilities as custodians of water resources. Watershed studies at the Coweeta Hydrologic Laboratory have so far only indicated some of the possibilities that lie ahead in this field of watershed research.

The practical application of watershed research is pertinent to many sections of the world where the local commodity value of water far exceeds the total value of harvested timber and other wood products. Here the management of the forests must be directed essentially toward achieving maximum yields of high-quality water at those seasons of the year when shortages usually occur. In the management of municipal and industrial watersheds there exists a particular opportunity for integrating high-quality, long-rotation timber crops with the production of high yield of quality water. Timber management practices can also be directed toward achieving sustained summer flow from headwater areas supplying water for hydroelectric power production.

Throughout the world the water resource is still the unexplored field in forest management. Practically nothing is known as to the effects of trees on water yields in tropical countries. It is quite possible that the cutting of coastal forests in equatorial latitudes has significantly altered the rainfall and hydrology of the interior. In higher latitudes there are many problems to be answered. For example, a change from hardwood to conifer forest, where this is ecologically feasible, has been suggested as a possibility for increasing water yield. Plant physiologists have not all agreed that this is a reasonable hypothesis. This subject and many more related problems have yet to be studied on a watershed basis.

The practicability of protected forests as a best type of plant cover for erosion control has in general not been questioned. In a few rare instances even this conclusion may be wrong, for there are unusual soil conditions where natural land-slips on steep slopes are said to be more common under large trees than under low herbaceous cover. Thus it is difficult to generalize and to do so may be misleading in the solution of local problems. Much more needs to be found out for specific areas in different parts of the world.

The most pertinent of all facts known to date is that careless abuse and damage of the forest soil starts into motion degenerative processes which may be inconspicuous at first, but which can produce gradually accelerating changes in soil structure that ultimately result in damage to the water resource. The conversion of arable areas to desert is the classic example. How to use the land and still maintain a reasonable equilibrium between deterioration processes and rehabilitation processes is a local problem in various sections of the world. Understanding these physical processes is the first essential.

Forest Ecology and Phytoclimatology

By A. DE PHILIPPIS

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THE word *ecology* has met with great favor among scientists concerned with the study of living things. Since its definition by Haeckel (1866), it has often been applied in various ways, sometimes referring to a general study of the factors of environment and sometimes having a narrower connotation. Several more precise terms have been proposed to explain the complexity of the relationship of living entities not only to the physical environment but also among themselves—for instance, *bio-coenology* (Gams, 1918) and *bio-ecology* (Clements, 1922)—but these terms, although perhaps more expressive, are unnecessarily redundant.

The study of ecology, unlike that of physiology, cannot be undertaken in the laboratory, with one or another element subjected to artificial isolation. The work must be done in the open under natural conditions, face to face with those combinations of factors which react one with another in many different ways.

An understanding of ecological factors, which are nearly always complex, can be arrived at either empirically or by inference, but the possibilities of experimental ecology are in practice limited by the need for special equipment, so that results are usually best attained by a combination of both methods.

The science embraced by the term *plant ecology* was practiced long before that particular expression was coined. Latin georgic writers were aware of the relationship between the life of agricultural and forest plants and their external environment, notably the edaphic and climatic requirements of many species, and the influence of adverse factors inherent in the environment.

Toward the end of the eighteenth century, more definite and well-founded knowledge began to be available when the first truly experimental observations, particularly those of Duhamel du Monceau, made it possible to confirm or refute conceptions which until then had been quite empirical. The same period witnessed the start of a series of explorations and voyages of discovery, the results of which formed the basis of causal phytogeography.

Space will not permit discussion of the evolutionary stages through which plant ecology has passed, and too many names would have to be mentioned. Such men as A. von Humboldt, A. de Candolle, A. Grisebach, O. Drude, E. Warming, A. F. Schimper were the authors of the most important general works on the subject published during the nineteenth century.

But we can give a brief outline of the development of *forest ecology*, namely that branch of plant ecology relating to the interdependence between the life of forest plants and the climatic, edaphic, and biotic factors of their external environment.

Today, forest ecology affords the scientific basis for silviculture, for it allows the forester to determine how he should carry out his silvicultural operations so as to create the least disturbance in the natural equilibrium.

The first evidences of the birth of forest ecology may be found in the more important works dealing with forestry which appeared in the nineteenth century, some being papers of a general character and others specific treatises, such as the well-known thesis of G. Heyer (1854) on the behavior of forest plants in relation to light.

Toward the end of the nineteenth and early in the twentieth century, a new foundation for silviculture was clearly discerned in the works of K. Gayer, B. Borggreve, and others, and more particularly in the writings of H. Mayr. Mayr's work *Waldbau auf naturgesetzlicher Grundlage* (1909) was the first to show this new trend by the title itself. Later on, more and more authors contributed to the assertion that a sound foundation for silviculture must be built on ecological knowledge.

Of the treatises published after Mayr's, it will suffice to mention the names of Morosow, Cajander, Bühler, Pavari, Rubner, Dengler, Troup, Toumey, whose works achieved renown and widespread circulation. Many other scholars throughout the world are the authors of important contributions on specific aspects, but it would be invidious to select even a few examples.

The Phases of Modern Forest Ecology

In modern forest ecology, several phases are discernible which are interrelated but by no means subordinate to one another. The *autoecological* and *synecological* phases include a detailed study of the relationships between species, or forest coenosis and the environmental factors. With the study of the boundaries of vegetative zones and the determination of such boundaries, we come to the *causal phytogeographical* phase. In the *phytosociological* phase (*typology* for certain schools of thought, and *biocoenology* in a more general sense), we come to the more specific analysis of the relationship of plants among themselves and with other forest organisms.

Through analyses and constructive studies a fund of knowledge has been obtained with regard to the limiting conditions of forest life (or of each forest species), the optimum or marginal conditions insuring its perpetuation (regeneration in a forestry sense) and growth; the phenomena of establishment, evolution and differentiation of forest stands, the possibilities of introducing species into areas with similar ecological conditions. A knowledge of all these factors is indispensable if silviculture is to be rationally directed towards its multiple aims.

The purpose of this article is to give a brief outline of the knowledge gained in the sphere of *phytoclimatology*, i.e., the study of the influence of climate as a limiting factor on forest distribution.

Phytoclimatology

There is no doubt that climate is the main factor affecting distribution, in the sense that its action is felt over wide areas of the earth's surface.

On the whole, the spatial distribution of vegetation is regulated by the climatic variations due to latitude, to distance from the sea, and to altitude. The variations due to historical factors or to edaphic or biotic factors (particularly the anthropic factor) usually have a more or less limited geographical bearing.

Broadly speaking, the influence of climate is clearly illustrated by the general superposition of the main categories of plant formations upon the main types of climate: thus, the evergreen rain forest is coincident with a moist equatorial climate; forests that are deciduous in the dry or cold season are coincident with tropical and temperate climates; forests of northern or mountain conifers, with cold climates.

This correspondence, already noted by the first phytogeographers, was more clearly defined and set in its logical context by Schimper (1898) and formally expressed in a few physiognomical classifications, such as Brockmann-Jerosch's and Rübel's (1912).

But the mere broad expression of such a correspondence is not sufficient to define acurately the relationship from cause to effect between climate and vegetation; one must be in a position to express the *extent* of this relationship by means of numerical values, showing the restrictions of the possibilities of expansion of a certain species, or of a certain phytocoenosis, in connection with climate.

For instance, what are the limits of temperature and rainfall that determine the transition from rain forest to other intertropical formations?

The study of such limiting values cannot be undertaken except through induction, clearly defining first of all the limits of the area of the species or of the coenosis under consideration, then inquiring into the climatic factors determining these limits and their relative influence.

In general, the predominating influence is the climatic factor which is at the minimum, or closest to the limits of tolerance (law of minimum, law of maximum, law of the limiting factor, law of the most significant factor). Most often, the limits are determined by a combined influence of several factors which react one upon another and may balance each other (law of relative influence, law of compensation).[1]

Research into limiting values is most difficult, owing to the lack of sufficient observation data covering all the climatic factors. The factors exerting the most general influence are heat and water. Data on heat (atmospheric or soil temperatures) is sufficiently significant, but information on water usually consists of indirect measurements only (atmospheric precipitation, humidity, evaporation, etc.). Information relating to the other elements of climate is rarer. This explains why attempts to circumscribe the phytoclimatic field have been based mostly on thermic and pluviometric data.[2]

Application of Thermic Data

The obvious parallelism between the sequence of thermic belts and of the large categories of vegetation, with the variations in latitude, did not escape the attention of the first students of causal phytogeography, who began to use *thermic data* in the study of climatic limits of plant formations. The "orange-tree climate," the "olive-tree climate," and the "chestnut-tree climate" as named by Soulavie (1783), the thermic zones referred to by Humboldt (1817), and the well-known megathermal zones and mesothermal zones of A. de Candolle (1855), were actually true phytoclimatic categories.

Subsequently, many authors used thermic values for the same purpose. A. de Candolle (1855), Merriam (1894), Selianinov (1928, 1930) used the totals of annual temperatures or of specific periods of the

[1]One special method of factor evaluation governing the climatic circumscription of growth areas is suggested by Boyko (1947). This author has laid down the "geoecological law of distribution," according to which the topographical distribution (microdistribution) is a function parallel to the general distribution (macrodistribution) of an ecotype or of a plant community; both distributions are the expression of the ecological amplitude of the ecotype or of the community.

This law should enable conclusions to be drawn, from an ecological-topographical study, which could be extended to the areas of general distribution of the species or of the coenosis under study.

The examples given by the author prove that such may be the case for the species or communities under observation in certain critical points within the limits of their areas, but we doubt that such a law can actually be extended to all cases.

[2]The phytogeographical importance of other elements is far from negligible, even if frequently indirect. *Light*, by which transpiration and photosynthesis are regulated, influences water requirements and may act as a limiting factor (e.g. in high mountain areas); resistance to cold may be altered by the variations in the periodicity of daily illumination, etc. The *wind* factor, by itself, can determine the restrictions on plant life; such is often the case in mountain areas, particularly on continually windswept summits. On the other hand, the polar limits of arborescent growth may be determined by the influence of icy winds but not by a thermic minimum (Kihlmann, 1890; Szymkievicz, 1930).

year. Quervain (1903), Holmboe (1913, 1927), Salisbury (1926) resorted to average monthly temperatures. Grisebach (1872), Mayr (1906), Livingston and Shreve (1921) utilized the thermic data of a given period (for instance, that of the period of growth or of the frost-free period); Köppen (1926), Walter (1927), Enquist (1929, 1933), and Rubner (1935) based their research on the duration of a given temperature. The annual thermic range (difference between maximum and minimum temperatures), which shows the more or less continental characteristics of a climate (from the thermic viewpoint), was also utilized for phytogeographical purposes, after the initial observations by Humboldt, Wahlenberg, and Grisebach.

Such data, taken individually, are generally not sufficient to permit a definition of the climatic conditions of a given station, and it is for that reason that a great many attempts have been made to combine both numerically and graphically two or more sources of thermic data. Among such attempts may be noted the definition of indices of "thermic effectiveness" (Thornthwaite's (1931) is one of the best known); the drawing of climograms, and the definitions of a few indices of an exclusively thermic character[3] such as Giacobbe's cold index (1937, 1949) and Gonzalez Vasquez' thermic factor (1933).

Humidity

The first element used to express humidity conditions was annual rainfall. The inadequacy of this information being quite obvious, certain factors such as the distribution of precipitation (pluviometric regimen), the number of rainy days, the evaporation rate, atmospheric humidity, etc., were taken into consideration, while synthetic formulae resulting from the combination of two or several factors were also established.

Thus Köppen (1900) utilized the relationship between rain and the maximum water vapor pressure of the rainiest month; Transeau (1905), the relationship between rain and evaporation; Meyer (1925), Rabbow (1927), the relationship between rain and the saturation deficit; Selianinov (1928, 1930) the relationship between rain and the total temperatures of the period of growth; Trumble (1939), that between evaporation and the saturation deficit; Emberger (1930), Chipp (1937) and others utilized indices combining the quantity of rainfall with the number of rainy days, etc.

The scarcity of data with regard to atmospheric humidity and evaporation has induced several authors to suggest terms in which these elements appear as functions of temperature.

Thus, a certain proportion of those indices are referred to as pluviothermic or hygrothermic (according to the elements used), but actually they are almost all humidity indices, as, for instances, the relationship between rain and the annual temperature (Lang's pluviofactor, 1916) or of specified periods (Martonne's index of aridity, 1926; Albert's reduced pluviofactor, 1928; Amann's hygrothermy, 1929; Emberger's pluviometeric quotient, 1930; Oelkers' pluviofactor, 1932; etc.). Szymkievicz (1925) suggested a correlation between rain and an index of evaporation based on the pressure, the relative humidity, and the maximum pressure of the driest month. Ängström (1936) propounded the proportion between rain and an exponential function of temperature; Setzer (1946) chose a similar term based on Van't Hoff's law.

Other authors used various elements to express the conditions of humidity (Gams' index of hygric continentality (1931), for example, is a correlation between particular functions of rain and altitude) or the combined conditions of humidity and temperature (Livingston's hygrothermic index (1916) which is the product of the sums of temperatures by the equation between rain and evaporation); Gonzalez Vasquez' phytoclimatic index (1933) resulting from the combined climatic and vegetative factors; Boyko's (1945) *IE* factor, which is an expression combining insolation expressed in terms of inclination and exposure, etc.).

As mentioned before, in the study of the effects of climate on ecological distribution all the factors, or at least the more important ones, must be taken into consideration at one time. This is necessary because the nature of limit, although determined by essentially thermic or essentially hygric factors, is never uniform all along the perimeter of the area of concurrence of a certain species or coenosis. It is for the purpose of taking this fact into account that phytoclimatic circumscriptions based on a *contemporary and coordinated consideration* of several factors have been suggested. One of the first attempts of the kind was undertaken by Köppen (1900), who delineated climatic categories whose boundaries, specified numerically, roughly represented the ecological boundaries of a similar number of categories of vegetation or plant formations.

Phytoclimatic Classifications Based on Vegetation

The first specifically phytoclimatic classification based on forest vegetation (in the Northern Hemisphere) is due to Mayr (1906) who distinguished between six different forestry zones: *Palmetum* (tropical zone of the palm-tree); *Lauretum* (sub-tropical zone of the evergreen oak and of the laurel); *Castanetum* and *Fagetum* (temperate-warm zone of the summer-growing deciduous forest, divided into a warmer and a colder zone); *Picetum*, (temperate-cold zone of the conifers); *Alpinetum* and *Polaretum* (the cold zone of the stunted arborescent shrubs).

The climatic boundaries of these zones are determined by Mayr on the basis of the following factors: the average temperature during the May to September period (considered as the period of growth), the annual average temperature, the minimum averages, the rainfall record of the growth period, the relative humidity of the same period, the date of the first and the last frosts. Thus, Mayr considers limits that are partly thermic and partly hygric.

Several years later, this idea was taken up by Pavari (1916). He pointed out the deficiencies in Mayr's diagram and suggested a more complex one which was much better characterized climatically (by means of annual average temperature, average tem-

[3]The influence of the thermic factor, in so far as the polar boundary and the alpine growth boundary are concerned, has been particularly studied by various authors such as Brockmann-Jerosch (1919), Rubinstein (1924), Langlet (1935).

perature of the coldest month and of the warmest month, annual minimum and maximum averages; rainfall distribution; quantity of precipitation for the year and for the warm season, respectively) and which reproduced much more faithfully the real distribution of forest formations. Disregarding the tropical zone, he maintained Mayr's five last zones, subdividing the first (*Lauretum*) into three types (according to the rainfall distribution) and three subzones (according to the temperature of the coldest month and the minimum averages); the second into two thermic subzones and each of these in turn into two types, on the basis of the conditions or the quantity of rainfall; the third and the fourth, into two thermic subzones.

Pavari's zones and subzones, at least in so far as the *Lauretum* and the *Castanetum* zones are concerned, differ considerably from those defined by Mayr, with which they have only the names in common.

In order of sequence, apart from the proposals of Cajander (1916, 1921) and Ilvessalo (1920), and other studies of a regional nature, mention should be made of the pattern suggested by Rubner (1934, 1935), whose limiting factor was computed by the number of days having a temperature above 10°C., and the classification plan of climates from the phytogeographical viewpoint, prepared by Emberger (1942), who, on the basis of the thermic and rainy areas, determined nine principal climatic categories.

These classifications make direct use of climatic data; others attempt to attain a closer approximation by utilizing, at least in part, a few of the abovementioned synthetic indices.

Emberger (1930, 1932) used his own pluviothermic index and the minimum averages of the coldest month in order to determine graphically the Mediterranean phytoclimatic distribution at various "levels" (arid, semi-arid, sub-humid, humid, and mountain).[4]

On the basis of the annual and monthly values as shown in de Martonne's index, Perrin (1931) attempted to identify the climatic boundaries of the main physiognomical forest types, as set forth by Brockmann-Jerosch and Rübel (*Pluvisilvae*, *Laurisilvae*, etc.).

Thornthwaite (1931, 1933) utilized efficiency indices for a phytoclimatic distribution of North America and of the world, based on the study of vegetation and soil.[5]

More limited research, geographically speaking, was undertaken in 1936 and 1949, for instance, by Giacobbe, who defined seven phytoclimatic areas for the Italian penisula on the basis of values pertaining to the annual thermic excursion, of the pluviometric system, and of both indices; also by Gonzalez Vasquez (1947) who distinguished, on the basis of the variations in the values of these indices, several types of climate corresponding to as many types of Iberian forests or plant formations.

As far as the methods used for combining and presenting data are concerned, the ingenious procedure adopted by Gaussen deserves to be mentioned. This author used illustrated charts showing the various climatic factors by means of appropriate colors of varying intensity, according to the influence of the factors themselves. A number of shades, each of which assumes a particular ecological significance, is produced by the superimposition of colors. This method is of paramount interest and its application up to date (see Gaussen, 1949 and preceding works; Cure, 1945, 1948) shows plainly the excellent results that may be derived therefrom.

Comparison of Data and Classifications

It is not possible to state which data or which classification are best suited to phytoclimatic purposes without undertaking a comparative study based on concrete evidence.

The most remarkable work in this connection, from the viewpoint of both the extent of the area under review and the wealth of data utilized, is the one by Livingston and Shreve (1921).

These authors compared the vegetation boundaries of the United States with a large number of climatic lines of isovalence, corresponding to specific values of certain data and thermic indices (varied indices of thermic efficacy and particularly the number of days in the frost-free period), and hygric indices (precipitations for the annual or for specific periods, the relationship between rain and evaporation, humidity, etc.), or hygrothermic indices (Livingston's).

Numerous comparisons show that certain boundaries (of the desert and the prairie) are essentially hygric in character; others (of the evergreen broadleaved formations), mostly thermic, and still others (those encompassing the deciduous broadleaved trees and the conifers) disclose a definite interference between the two types of factors.

The main conclusions to be derived from this study are as follows:

(1) Comparisons by means of charts can bear significant results only if applied to very large areas;

(2) An adequate measure of agreement between vegetation and climate area may be determined only if the climatic delimitation is based on two or more factors;

(3) The correspondence between the boundaries of vegetation and a few isoclimatic lines does not constitute a conclusive proof of causal correlation, because the influence of climatic factors is always collective and interdependent;

(4) The isovalency lines of a few factors may be parallel and in such a case, to particularize the most efficient factor, a study of correlations in critical sectors must be made for each factor.

Some other comparative studies are Pearson's work (1931) on the Southwestern United States; Hessel-

[4] The phytoclimatic boundaries of the Mediterranean region are being studied by the FAO Mediterranean Subcommission which, at its 1948 and 1950 meetings, discussed the principles according to which a special ecological map should be drawn up.

[5] In a more recent work (1948) Thornthwaite no longer makes use of this empirical criterium, for he prefers to determine the *rational climatic boundaries*, starting from a comparison between the potential evapo-transpiration (that is to say the quantity of water that would be restored to the atmosphere through evaporation and transpiration under optimum conditions of soil humidity and plant cover) and the rainfall. Such a comparison brings out values indicative of abrupt climate variations, which the author calls points of fracture, corresponding to actual climatic barriers. It is difficult to determine to what extent the purely climatic classification which has been evolved by Thornthwaite may be used for phytogeographic purposes.

mann's (1932) on Sweden; Gams' (1935) on the Mediterranean region; De Philippis' (1937) on Italy.

If a conclusion can be drawn from these studies and others of the same type, it may be asserted that with the data available at present it is practically impossible to arrive at solutions applicable in every case, whether general boundary lines (on a geographical scale) or more limited outlines (on a local or topographical scale) are desired.

The multiplicity of studies, particularly concerning the determination of synthetic formulae, is in itself a definite indication of the complexity and variability of the problem.

In general, it may be said that the classifications based on the direct use of observation data may have a more general meaning, and that a judicious choice of data and their combination (in tabulated, graphic, or cartographic form) may yield an adequate approximation for the requirements of phytoclimatology. On the other hand, such classifications are of little help in the case of limited geographical areas or of exhaustive research; it is then time to utilize synthetic indices.

The use of these has on the whole given less satisfactory results than were expected. In fact, not all indices have proved to have a really phytoclimatic meaning (or a bioclimatic meaning in a more general sense) and at any rate, such meaning does not exceed the boundaries of climatic areas encircled, for instance, by a certain thermic belt.

This inadequacy of synthetic formulae (already pointed out by this writer in 1937) is due to the quite often erroneous choice of mathematical expressions of indices as functions of the variable factors considered. Thus, even though it is a fact that the humidity of a station increases as the rainfall increases, and decreases with the rise in temperature, nothing proves that this is a ratio either direct or inverse, such as that expressed in ratio $\frac{P}{T}$, for instance.

Efforts have been made to obviate this drawback by resorting to coefficients of correction generally of an empirical character, but in spite of such efforts no standard formulae have yet been found.

A progressively closer approximation will doubtless be arrived at, either for classifications or for indices, when more ample information is available on a greater number of climatic factors, and, above all, when there have been longer periods of observation. When that time comes, it will be possible to select from the more significant and suitable data and to enlarge upon such information (taking into account not only the intensity, but also the periodicity and the frequency with which each climatic factor exercises its influence), and also to determine more clearly the influence of each factor, even in the case of parallel variations or of indirect influences (e.g., physiological aridity due to a low temperature).

This conclusion fully justifies the earnest efforts being made to establish climatic classifications or create synthetic terms of a concrete ecological meaning, which would benefit the scientific and practical purposes of forest phytoclimatology. Such aims include the knowledge of the climatic determination of growth areas, the delimitation of optimum or marginal sectors of the areas of the various forest species, the search for climatic analogy[6] between various areas of the earth's surface, and so forth.

[6]The method of "climatic analogies" applied in silviculture by Mayr and Pavari for cultivation purposes (introduction of exotic varieties) has also been widely utilized in agriculture by the Russians and more recently by the Americans. (An interesting series of articles on agroclimatic findings is now being published by the American Institute of Crop Ecology.)

Panorama of the area surrounding the Coweeta Hydrologic Laboratory whose work is described in the article, "Research in Forest-Streamflow Relations," appearing on pages 2-9 of this issue. The photograph shows the local land use pattern outside the Laboratory boundaries. In the center can be seen a 40-acre experimental watershed which was cut two years previously to determine the effects of removal of forests on stream flow.

Advances in Forest Genetics

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Douglas fir: V.661 is a grafting from a selected tree in Denmark. It has been grafted in a crop heavily attacked by Phaeocryptopus gaumannii, *and thus seems to be resistant to that disease.*

IT MAY seem remarkable that the silviculturist should lag so far behind the farmer or the gardener in the use of improved plants. There are perfectly good reasons for this.

Genetic improvement is based on the fact that no plant within the same species is identical with any other and that, by using the best individuals, the desired better types can be raised. Similarly, it is possible to make crosses between species and types in such a way as to get a combination of the qualities desired.

By sexual reproduction from seed sorts can be produced, as in the farmer's cereals, root crops, and grasses, or in many of the gardener's flowers and vegetables. These are mostly plants which furnish a sexual generation every year or every other year. By using generations which follow each other rapidly it has been possible, by constant selection and by artificial interpollination, to propagate fixed strains.

Clones, which are used in the propagation of fruit trees, roses, and similar growth, are a quite different form of "sort." They are widely distributed by vegetative reproduction. Clones can be applied by grafting, budding, cuttings, or layering. From plants with choice fruits or fine flowers, which may have arisen more or less by chance, shoots (grafting) or individual buds (budding) are taken and transferred to wild seedlings (stocks). Every one of these sorts is thus an individual in itself which, if grafted or budded, will grow on countless alien roots or give rise to complete or independent plants through cutting or layering.

The method chosen by the farmer or horticulturist in individual cases of improvement depends upon the characteristics of the plants and on the practical possibilities. It is particularly important that attention be paid to the rate at which generations succeed one another; to flowering conditions, such as the time of appearance of male and female flowers; to insect pollination or wind pollination; to the amount of seed yielded by the individual plant and, hence, the necessity to observe the capacity of the plant for vegetative reproduction; and to many other points.

In forestry, any attempt to obtain "fixed strains" of forest trees by artificial pollination runs up against the difficulty of tree height. It is not easy to pollinate by hand, high up in the crowns of trees. Furthermore, the trees are often scattered over wide areas and cannot be transferred to convenient experimental areas. In addition, it may take ten, twenty, or even forty years for a tree to set its own seed.

It is therefore not surprising that the idea of artificial pollination was abandoned and that no one had any faith in the regeneration of forests by grafting or by cuttings. Broadly speaking, therefore, intensive silviculture places most reliance on improvement of the forest's growing stock by the introduction of exotic tree species and by selection of the best indigenous trees under conditions of free, uncontrolled pollination. Very important progress was made, however, when it was recognized that forms of forest trees do exist which can be determined by heredity, and when first steps were taken towards intentional improvement, even though that progress did not go beyond selection on the basis of free, uncontrolled pollination.

Finding good seed

The first and main step was to look for the best possible seed for reforestation. Accordingly, the demand for authoritative information on the provenance of seeds grew steadily, and various systems of control were set up in several countries. International cooperation in this field is of the greatest importance, so that information can be exchanged and, if possible, some progress be made toward establishing uniform rules of procedure or, at least, toward an exchange of views on the inquiries submitted and on the methods of dealing with them.

In this connection it would seem wise to pay attention not only to the climatic races and types which occur naturally and which show a particularly good form from a forestry point of view, but also to those types which presumably have been developed under the influence of man. Particular mention should be made of the oaks of the Dutch avenues, the European larch (*Larix decidua*), and the Douglas fir (*Pseudotsuga taxifolia*) of western America growing in Scotland, not to speak of many other examples both in the Old World and in the New. Reference should also be made to the widespread propagation of *Hevea brasiliensis*, which furnishes by far the greater portion of the world's crude rubber, almost all of which is derived from plantations located outside the natural growth habitat of the species; the extensive plantations of this tree are based on extremely small quantities of original seeds.

Such a segregation of species may have considerable advantages, but it may also involve the risk of excluding valuable chances of variation. This is, however, of no account in comparison with the great advances made in agriculture and horticulture, especially during the past fifty to one hundred years. The bumper crops of today, in fields and in gardens, exceed by many times the crops of a few generations ago. The modern improvement of maize through hybridization —the first theoretical tests of which were made about 1917—is estimated to have yielded, in the year 1947 alone, a profit of $750,000 to $1 million.

We have seen with envy how some other users of the soil have been able to progress through the use of plant improvement techniques. In forestry, unfortunately, too much emphasis has been placed on the difficulties involved, and these techniques have been neglected. The difficulties are great, if the same procedures are tried in forestry as in agriculture and horticulture. Forestry should go its own way and then, perhaps, things will assume a different aspect.

The most important methods of procedure in forest plant improvement work are:

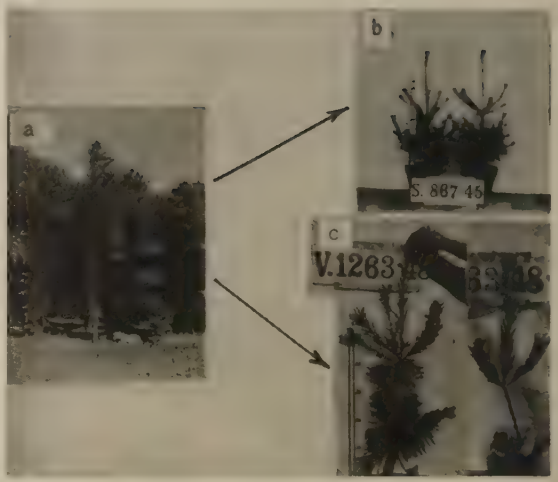
(a) Investigations to determine hereditary differences within species: races determined by climatic factors and special form types, which have grown both naturally and in cultivation—that is, the problem of provenance in its widest sense—with planned experiments based on free, uncontrolled pollination.

(b) Artificial pollination on the basis of previous studies of the flowering of forest trees.

(c) Hybridization, especially the utilization of hybrid vigor, or heterosis.

(d) Cytological work to identify trees with chromosome numbers differing from the normal, and the reproduction of such trees.

(e) Vegetative propagation, which is of the greatest importance as a technical method of forest improvement, by the establishment of seed-source plantations and tree shows or displays, which may also be of special importance for the utilization of a tree of any given character (clone).



Pinus strobus: *a.—Old tree, Uggeløse Skov, Denmark. b.—Seedlings propagated by controlled pollination carried out in 1944 in the crown of the old tree. c.—Grafts from the old tree, grafted in 1948; the grafts flowered in 1950. (b and c were photographed 30 June 1950.)*

Preserving the best types

First and foremost, the best possible types of economically important trees should be preserved for the future. Each country should register its most valuable stands, preferably in virgin forests, or any particularly outstanding individuals—elite or champion trees. This task is closely related to maintaining national parks and preserving natural sites. The elite trees should be used in planting work, either by use of their seed or preferably by vegetative propagation (grafting, budding, or by cuttings) so as to achieve the preservation of these presumably valuable genotypes, which will at the same time become available for further use. This step would in any case offer a certain safeguard against deterioration.

In Denmark this work is carried on by the State Arboretum. Because of its forest-botanical nature it is a task which comes naturally within the scope of the arboreta in various countries, whether they are attached to forestry colleges, research stations, or other institutions. It is time to get away from the old collections with all their monstrosities. It used to be the custom to collect such items as weeping ash, snake spruce, and globosa- or pygmaea-shaped trees, instead of concentrating mainly on elite individuals from the forest.

Distance is an important problem. Often the trees which should be collected are scattered over a wide

area, so that it seems impracticable from the start to make use of them. Much would already be accomplished if selected champions were taken into the arboreta. The best way to do this would be to get seed from the good stands and through vegetative propagation of fine individual trees. A jeep with a Swedish steel ladder can travel far afield and can be used for collecting material from quite high trees. If it is still difficult to reach very high into the trees, small bits of branches can be shot down.

Grafts by air mail

For transportation over great distances, air mail and air express are available. Within three days I succeeded in getting quite an amount of grafting material into Denmark from California. On Wednesday the grafts were dispatched from San Francisco, and on Saturday the grafting began in Hørsholm. We have been sending pollen of *Pinus* from Denmark to Placerville, California, and, since the spring of 1946, we have annually received pollen from Canada, both for experimentation and for commercial production of *Populus* hybrids. We have received pollen of *Pinus* from Australia and have made quite a number of other exchanges of the same kind. In the course of a few years this material, the exchange of which is so essential to us, will certainly become a very common cargo.

Even more than distance, perhaps, time acts as a deterrent. However, there is a whole series of important forest trees which produce considerable quantities of seed at comparatively young ages, even if they are grown as ordinary seedlings. As examples from among the important trees in European forestry *Betula, Larix,* and *Pinus* may be mentioned. Trees aged from ten to fifteen years may still bear considerable quantities of seed, provided that individual plants are spaced widely enough apart so that the crowns can develop properly.

Grafting offers certain advantages. It appears that grafts are capable of producing seeds at still earlier ages, even if they are planted in the forest in the same manner as other trees. Wounding, strangulation, or root-pruning can also be used to hasten seed-bearing. It has been clearly proved that grafts, treated by special methods—grown in pots or subjected in some other way to special treatment—can be used as small, early-fruiting plants for experimental purposes. It is a great advantage in a greenhouse to work with seed-bearing potted plants. If it can be ascertained that the grafts have exactly the same genetic characters as the elites from which they are taken, this material can afford great opportunities for future research.

Identification of the genotype in forest trees is also a difficult problem. Considerable headway can be made through proper silvicultural treatment, but it is nonetheless a great advantage if one can work with trees which possess an inheritable tendency to furnish the strongest growth, the straightest stems, the highest resistance against diseases and insect attacks, and have other valuable silvicultural qualities. Forest trees are dwellers in communities where, like other living organisms, they have to adapt themselves to the existing conditions. These conditions may differ considerably in the course of time, all the more because trees live so long and may be subjected to many different external influences.

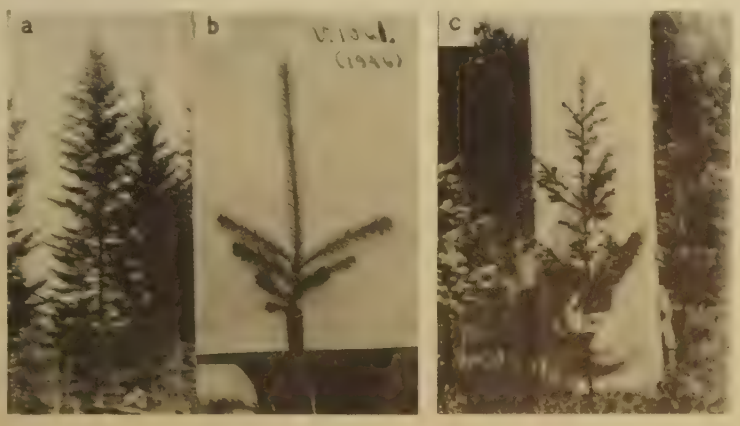
The value of tree shows

As an aid to identifying the genotype of trees in Denmark we have initiated "tree shows." These consist of plantations of groups of various sizes of plants propagated vegetatively, so that each group, usually 30 plants, represents its own particular tree — its clone. For this purpose the most reliable results are obtained by using cuttings, but grafts also permit reliable observations. In the arboretum at Hørsholm we have found these methods very helpful in identifying the genotype of the clones of *Fagus, Fraxinus, Betula, Larix, Picea,* and *Pseudotsuga.*[1]

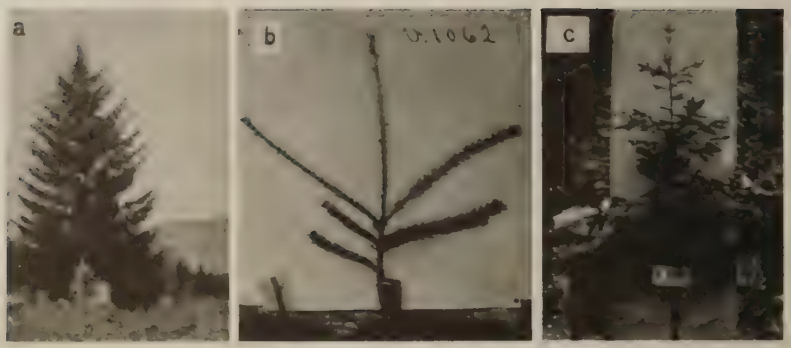
These tree shows are a means of demonstrating the existence of various genotypes. They also present a good establishment for continued observations and tests. Moreover, they can be laid out in such a way that they permit the testing of individual genotypes under different environmental conditions, and the work can be developed in other directions.

There is space for only a hint, but tree displays may also be very valuable for phenological observations and as laboratories for studies in plant physiology and plant pathology. Through such studies the great individual differences in plants become quite

[1]C. Syrach-Larsen: *Estimation of the Genotype in Forest Trees,* 1947.



Douglas fir 1: a.—Original tree, Wind River, State of Wyoming, U.S.A. (photographed 17 April 1946). b and c. — Graft (V.1061) on old stock in Denmark, 29 April 1946. (b was photographed 25 September 1946 and c, 26 June 1950.) When comparing Douglas fir 1 with Douglas fir 2, shown on page 18, it becomes evident how extremely different are the genotypes of the two trees. It is remarkable that it is possible to notice this difference in the photographs taken in 1946 (see b). By 1950 (see c) the distinction is obvious.



Douglas fir 2: a. Original tree, Wind River, State of Wyoming, U.S.A. (photographed 17 April 1946). b and c.—Graft (V.1062) on old stock in Denmark, 29 April 1946. (b was photographed 25 September 1946 and c, 26 June 1950.)

apparent; these differences are the basis of improvement. It is surprising how much knowledge can be derived from this kind of work, and how rapid is its progress. Another matter of interest is that, by making grafts — or, better, cuttings — we can try to verify the importance of provenance. It might be possible to set up "living meteorological stations," so to speak, or to initiate the use of "type trees." It is often said that plant improvement work should follow the plant from "the cradle to the grave" in order to be sure of finding the right and most valuable plant, but I believe that in forestry we should follow the individual tree from "the grave to the cradle," as we are doing in our use of tree-displays.

The farmer sows his seed and watches the plants develop until time for the harvest. He can easily do this, for the whole process only takes one or two years. But doing the same would be a tedious pursuit for the forester. He must use a short cut, such as the tree display. The shapely, full-grown tree in the forest stands at the edge of the grave, but it has made clear to us that it could become the ideal tree. If we take grafts from it and establish them in a tree-display, we then have an opportunity to study the congenital characters which have made it such a valuable tree. In the course of a few years we can find the reason for its superiority — whether exceptional vigor, great hardiness, or a special resistance to diseases. This is what I mean by saying, "we have followed it from the grave to the cradle." It is, however, a striking example to illustrate that we must follow paths other than those usually taken.

With regard to seed-production, "I strongly urge taking up vegetative propagation and, in conjunction with experiments on artificial pollination, the establishment of seed plantations for the supply of seeds for practical use."[2] It is an old quotation but it states an objective which we should strive to attain.

Seed-source gardens

There may have to be certain modifications, as for instance that in certain tree species the greater part of the planting will be done with seedlings taken from controlled pollinations on grafts from champion trees. There may also be other useful combinations, but certainly there should be special seed-source plantations or—as they might better be called—seed-source gardens. It is quite certain that an intensive forestry such as we have in Denmark should employ seed-source gardens. I believe, however, that they can also be recommended for use under more extensive conditions. For example, in the United States of America and Canada, they would be the natural link in advance of the more general tree-farms grown there.

In Denmark the work has been so organized that most of the experimental work on forest-tree improvement is concentrated at the State Arboretum, whereas the establishment and control of seed-source gardens is the main task of the State Forests Plant-breeding Station.

Above all, seed-source gardens, which are formed by vegetative propagation from elite trees, will be our trump card. We should not cast envious eyes on the favored position of plant improvers who work with herbaceous plants, but rather look at the matter the other way round. Paradoxically, it may be claimed in respect of short-lived plants that we must confine ourselves to types which seed consistently or breed true in order to preserve them, whereas with forest trees we can preserve valuable hereditary tendencies in the same individuals, perhaps for centuries. Therefore let us not lament the slow succession of generations, but rather rejoice at the long life of individuals.

In seed-source gardens we have, in addition, special opportunities for making use of hybrid vigor (heterosis). We can not only readily produce seed of any desired hybrid but we can also produce it from parent trees selected for that purpose.

In this connection it may be mentioned that F. I.

Fraxinus excelsior: *a.—Old tree, Stenderup, Denmark. b.—Graftings from the same tree with seeds in greenhouse, 22 August 1939. c.—Seedlings of the seeds shown in Fig. b, germinated 1941 (photographed 1942).*

[2] C. Syrach-Larsen: *Forest Tree Breeding*, 1934, page 112.

Righter of the Institute of Forest Genetics at Placerville, California, recommends the utilization of hybrids by employing seed from F_1 generations without controlled pollination. Placerville works almost exclusively with *Pinus*. They have quite a number of hybrids of *Pinus*, of which *P. attenuata* × *P. radiata* is the oldest (sown in 1929), and their experience is doubtless based on it. I have obtained with *Larix decidua* × *L. leptolepis* astonishingly good progeny in controlled F_2- and back-crosses, and I also recollect seeing in Scotland beautiful plantations derived from free pollination of both F_1 and F_2 at the same crossing.

I should like to direct attention to the "polycross-method," used with success in recent years in agricultural plant improvement.[3] The method is particularly recommended for plants which are cross-pollinators, which can be divided into clones and thus be preserved for a number of years, as is the case with forest trees.

By employing the "polycross-method" plants can be sought with high "combining ability." If, from the forestry point of view, trees with sufficiently high combining ability could be found, it might pay to introduce them into stands, even where natural regeneration is being used.

Seeking always for the best, we must, working with the greatest precision, come to grips with the heart of the problem so we can make later use of the discoveries in practice. It is up to each of us to tackle the problems as we see them, but at the same time we must co-operate with others the best we can.

Pioneering in genetics

This is pioneering work: Studies of growth stimulants, which may make possible a more general use of cuttings, and painstaking cytological researches are of equal importance with theoretical meditations or the use of well-tried horticultural methods.

We must strive for vigorous growth—perhaps not exactly gigantic stature — we must to a great extent hunt for resistance to disease, and it must be our special aim to increase the volume production per unit of area. In these ways forest tree breeding may make its contribution to an expanded afforestation.

When the pioneers reached the North American prairie it was covered by a "sea of grass," which at that time they considered themselves lucky to get gratis, but the farmer has long since found that it is to his advantage to turn under the original grass and cultivate new and more desirable kinds of grasses, even though it costs money and labor. The same must hold for the forester, if he is to succeed in meeting the demand for wood by the paper and chemical industries, in which the consumption becomes steadily greater, as well as for many purposes which make precise demands on the structure and technical qualities of timber. There will be a steady demand for special biological qualities in trees to provide shelterbelts for farm crops against wind and blown sand, and in those species and types of trees and bushes which are needed to assist in regulating rivers and in protection against erosion. It may well become the task of the forest tree improver to find material for planting on vast areas where man's activities have had a specially disturbing effect. Special planting materials may be needed where industrial areas poison the atmosphere, or where the gigantic mountains of sand from the South African diamond mines blow right into people's houses, or in the struggle to free the Suez Canal from the incessant blowing of sand from the adjoining desert.

To succeed to any appreciable extent in forest tree improvement, we must soon approach the stage where it becomes obvious how much more profitable it will be to create rapid-growing pure plantations on favorably situated areas rather than going on the hunt for countless different species in virgin forests, or waiting on the regeneration of the forests of the Far North. Those regions of the world favored by abundant light, heat, and moisture will hold out highest possibilities.

We must be keenly alive to all the possibilities that may arise, from whatever quarter they may come. But, whatever happens, we must take up the task with optimism. If we dwell rather on long-lived individuals than on the slow succession of generations, the future of the work immediately becomes brighter — possibilities are opened up for attacking tree improvement in an entirely new way, and the silviculturist may yet overtake the agriculturist and the horticulturist.

[3] H. N. Frandsen: Imperial Agricultural Bureaux Joint Publication No. 3, 1940; H. K. Hayes: *American Naturalist*, Vol. LXXX, 1946; and H. M. Tysdal and Bliss H. Crandall: *Journal of the American Society of Agronomy*, Vol. 40, 1948.

Exchange of Research Materials

By agreement with the President of the International Union of Forest Research Organizations, FAO is prepared to publish in Unasylva *short notifications and requests concerning research and research materials sent in by Research Institutes and individual research workers.*

The following item has been received from Carl Muhle Larsen, Union Allumettière S. A., Institut de Populiculture, 230 rue Buizemont, Grammont, Belgium:

"For our breeding work within the genus *Populus*, we are looking for specimen material from *P. nigra*. Both the true species and varieties are of interest; but the branches must be from healthy stock, and preferably from trees with good form and growth. For direct utilization the first year the small branches, 30 to 50 cm. in length, must bear flower buds.

"We should be glad to hear from research institutes of possibilities for obtaining such material, and for its consignment to us. Carriage expenses and other costs will be paid by our Institute."

Planning and Statistical Design In Silvicultural Research

FOREST research is primarily concerned with the behavior of plant crops with a long life span. For this reason it differs from agricultural research in several important respects. In agriculture it has often been possible to obtain conclusive results from research in a few years, because agricultural crops develop from seed to maturity within a single growing season. In the forest, observation of the behavior of a single crop from youth to old age, and determination of the response of that crop to various means of treatment, may require a period of fifty years or more. A single forest research project may be started by one individual or group of individuals, it may be continued by several successive groups, and it may be completed by men who were not born when the project was established.

There are, of course, certain classes of forestry problems, such as those arising in nurseries and plantations, regarding which valuable research results can be obtained in a short time. Many problems in mensuration can also be solved rapidly. But it remains true that the majority of forest research undertakings require a long time for their completion.

Since individual forest projects are observed by different men at different times, it is particularly important that plans for any forest research project be thought out with the greatest clarity before actual work is commenced and be set down on paper in the greatest detail. Unless this is done, it becomes practically inevitable that changes in methods of measurement, etc., will be introduced from time to time, with results very damaging to the validity of the eventual conclusions.

The importance of proper planning to the success of silvicultural research was emphasized in a recent report of the Subcommittee on Planning and Statistical Procedures of the Society of American Foresters. The Subcommittee draws special attention to the advantages to be gained from the use of modern statistical methods in the design and analysis of silvicultural research projects. Through the courtesy of the editors of the *Journal of Forestry* we have been permitted to summarize that part of the Subcommittee's report relating to planning and to quote in full the section dealing with the use of statistical methods.

Planning Silvicultural Research

Any program of silvicultural research consists of a number of individual studies or projects. Plans for the general program may consist chiefly of the definition of its objects and the principal problems which it is intended to solve. The program plan must then be supported by detailed plans for individual studies or projects. Each project plan must bear a direct relationship to the general program. The individual plans, taken together, should constitute a restatement in detail of the general program and of the means proposed for carrying it out.

The principal objects of a silvicultural research program are determined by the physical conditions and practical problems existing within the district or region to which the program is to apply. Since financial and other resources are always subject to limitations, it is necessary to decide which individual problems should be given the highest priority. Valid decisions must be based on accurate knowledge of the relative importance of different practical problems within the region. Given this knowledge, it is necessary to consider what research projects might be undertaken, regardless of practical limitations; what projects ought to be undertaken from the point of view of the practicing silviculturist; and what projects it is possible to undertake with the staff, money, and other facilities actually available.

When assigning relative priorities to different studies, preference should be given to those promising results of the greatest practical usefulness, those which will fill critical gaps in silvicultural knowledge, and those of the greatest importance to the development of further research programs.

The first step in developing a program is an examination of research studies already undertaken in the region concerned, and an assessment of their value. This is always necessary in order to avoid useless duplication of work.

The second step involves selection of specific projects to be undertaken. Selection is guided by considerations outlined in the previous paragraphs and also, and to a very important degree, by the capabilities and experience of the research staff. Since research

programs are always limited in comparison with the need for new knowledge, it is most important that any work undertaken be done well. Therefore, every effort should be made to assign to individual members of the staff projects which engage their interest and lie within the range of their capabilities.

When a program has been planned and studies have been chosen, it is necessary to select methods appropriate to each individual project. Suitable working hypotheses must be developed, and these in turn influence the selection of methods.

Each research project is planned in the hope that it will provide complete or partial answers to some specific question. Proper formulation of the questions to be answered and of the hypotheses to be tested in seeking for the answers will provide a preliminary definition of the project.

Many forestry research projects involve repeated measurement of selected forest characteristics over long periods of time. To illustrate, it may be necessary to remeasure established sample plots at five-year intervals for twenty or thirty years. Under such circumstances it is particularly important that written plans define exactly what characteristics are to be measured, the methods of measurement, and the instruments to be used. Only thus can there be reasonable assurance that the results will be comparable with the original work and with each other.

A satisfactory working plan for an individual project should include:

(1) A clear, precise statement of the questions to be answered.
(2) Provision for review of the relevant literature.
(3) A statement of the hypotheses to be tested.
(4) A statement of the methods to be used, including details of the experimental design.
(5) Method of presenting the results.

Item 4 is of particular importance; correct design of an experiment is essential if significant results are to be obtained. The design of research projects which depend upon sampling, instead of complete measurement of the universe being studied, should be guided by the principles of modern statistical theory. Otherwise, there may be no sound basis for determining whether observed differences between different areas or apparent differences resulting from different treatments are of real significance or are merely accidental. Failure to plan correctly has greatly reduced or even nullified the value of many research projects in silviculture.

The following discussion is reprinted from the report of the Subcommittee on Planning and Statistical Procedures, Society of American Foresters:

Statistical Methods in Silvicultural Research

Why statistical methods are needed. If there could be one and only one answer to the question "What is the diameter of that tree?", and if a definite percent, no more, no less, of every lot of yellow-poplar seed were viable; in other words, if measurements were not subject to error and living things to unaccountable variation, there would be no need for statistical methods. But measurements are subject to error and living organisms do vary even under controlled conditions.

Experimental results are, therefore, not absolute, but variable; and so the basis for action they provide cannot be absolute or perfect; it is only more or less reliable. The evaluation of the reliability of experimental results is a function of statistical methods, along with the designing of efficient experiments and the skillful analysis and condensation of experimental results. Statistical methods are, however, not the whole of silvicultural research, or of any other kind of research. They are only an aid to, and not a substitute for, the right use of human reasoning power.

A *model of variability.* Just as mathematical models—paraboloids, cones, neiloids—are used to help in the calculation of the volume of tree trunks, so mathematical models have been set up to help in dealing with errors of measurement and the uncontrolled variation in living things. One such useful model is the "normal curve of error." Although we have not yet found ways to make trees grow more like paraboloids, or neiloids, we can make the variability of our forestry data approach the normal curve of error by properly collecting and handling such data. For example, treat the several thousand planted trees in a uniform plot alike. Measure the heights of 30 of them. The heights will vary and the pattern of variation may look little like the normal curve. Take heights of 30 groups of 30 trees each. The 30 averages of the groups will vary, but the pattern will be closer to the normal curve of error than the 30 single measurements. The fact that the variability associated with our data fits the mathematical model better and better as the number of observations increases, strengthens our confidence in the model.

The normal curve of error is based on the laws of chance. If we are to make use of the formulae derived from it we must be sure that every one of the trees in our uniform plot had an equal chance of being selected for measurement in our samples, that is, they must have been chosen at random. This seems sensible, too, for we are well aware that if we picked tall trees only, we would get a biased average, no "honest" answer to the question: How well are the trees growing on that plot?

Over and above these and other evidences that the mathematical model set up by the statisticians does really fit the kind of variability we deal with in biological research, use of statistical methods has the great advantage that it compresses and distills, by standard procedure, masses of data that would be unmanageable in the raw. Condensation of data in a variety of ways, each research man using his own, would be confusing and inefficient—just as it would if each one used a language of his own. The accepted "language" not only of biological research, but of science in general is the statistical method. Workers in silvicultural research cannot afford to be unfamiliar with it.

Some statistical procedures useful in silvicultural research. It is not the purpose of the com-

mittee to teach the use of statistical methods, but rather to tell why this tool is needed and to point out situations in which it is useful.

Consider now an experiment to determine the effect that the addition of organic matter to the soil has on the height of nursery seedlings at transplanting time. The average height of seedlings in the humus-treated bed is found to be greater—say 3 inches greater—than the average height of seedlings in the untreated bed. But the best seedlings in the untreated bed are taller than the poorest ones in the treated bed. How reliable is this 3-inch difference in the averages? Statistical methods provide a standard test—the test of *the significance of differences*—which, if the rules are followed, will measure the probability of so large a difference happening by chance. If it could have happened only very rarely by chance, that is, if it was not "just an accident," we would recommend the use of humus to increase, by about 3 inches, the height of seedlings at transplanting time. The same statistical procedure will, incidentally, furnish an estimate of the variability of results to be expected in the use of this treatment under the same conditions. The decision whether the 3-inch increase, with its liability to variation, is worth while and of *practical* importance is beyond the field of statistical methods.

Note that we made the prediction about the effect of adding humus on the assumption it would be used "under the same conditions." Conditions are, of course, never really the same. In fact, if we compared a single treated bed with a single untreated one, a part of the difference in height might have been due to differences in the original texture or fertility of the soil. If we had selected at random from all the beds in the nursery a number—say 6—to which to add humus and the same number to leave without humus, we could then have determined how much seedling height at transplanting time varied in beds treated alike, and by a statistical procedure called *the analysis of variance*, could have arrived at a more precise measure of the effect of the humus treatment and of the variation associated with it. As a consequence, we could have predicted more reliably what to expect following use of the treatment. Go a step further. Suppose half the humus-treated beds and half the untreated beds had been watered. The analysis of variance would then enable us to evaluate the effect of watering and the effect of humus treatment separately, with the variation associated with each. We could also evaluate their combined effect; and their interaction, that is, determine whether response to watering is the same in humus-treated beds as in beds not humus-treated. More complex experiments to test the separate and combined effects of larger numbers of treatments and their interactions are readily handled by the method of analysis of variance.

Problems involving the relation of changes in one thing to changes in another are common in silvicultural research. How does the volume of even-aged Douglas-fir change as the stand grows older? If we measure the diameters, heights, and volumes of a number of loblolly pines, how can we analyze the data so as to estimate the volumes of other loblolly pines from measurements of their diameters and heights? The statistical procedure *correlation* is most useful in these and similar cases. The method of correlation has the advantage of being objective: it does not require the personal judgment that must be used to draw freehand curves. It can handle any number of variables: in graphic work two independent variables are about the limit. The procedure is standardized so that all workers using the same data would come out with the same result. It provides a measure of how much of the original variation in the dependent variable is accounted for by its correlation with the independent variables, and evaluates the error of estimate to be expected in making predictions.

Hardly a study can be made in silvicultural research without using *sampling*. In each of the examples described so far it was necessary. Not all the trees in the uniform planting could be measured, and certainly not all the seedlings in the nursery beds. Wherever measurement of a part of the individuals in a population must be made to serve instead of measurement of all the individuals, sampling is involved. This branch of statistical methods tells how to take unbiased samples, representative of the population; how to estimate the number of plots needed in an experiment; how to sample efficiently by using devices that increase the precision of sample averages without the need to increase the number of measurements; how to apply the results of sampling accurately, and to best advantage.

Finally, *the design of experiments* integrates the physical layout of the plots, trees, or other things being studied with the schemes that are to be used in analyzing the data. Experimental design dictates how the plots and trees are to be selected for treatment to avoid bias in the experimental results. Basic to all good experimental design are randomization and replication. That is to say, precautions must always be taken so that the personal judgment of the experimenter shall not determine which plots or trees are to be treated one way and which another, and always each of the treatments must be applied not to one plot or to one tree, but to a sufficient number so that the variability of the results can be measured.

In the humus-treatment experiment, outlined above, we used a simple experimental design involving 12 randomly selected plots in a nursery. Proper procedure would require that each of the 12 plots should have equal chance of being treated with humus or of being left without it. That is what we mean by saying that the treatment should be applied at random to half of the plots. Similarly, when we refine the experiment further by watering half of the beds, those to be watered must be selected entirely by chance—this can be accomplished by drawing numbers out of a hat, or in any other fashion that makes it impossible for the experimenter to decide ahead of time which plots are to be treated.

In this experiment four treatments were used: some plots received both humus and water; some received neither; on some humus was applied and water withheld; and on some humus was withheld

and water applied. Note that each treatment was used three times. Thus the experiment was balanced and provision made to measure the variability of the results. Complex designs for more complicated situations are available in the textbooks.

Conclusion. The objective of all experimental design, as well as of statistical methods in general, is to get the greatest amount of accurate information for the outlay of manpower, time, and money. Without a working knowledge of statistical methods no worker in silvicultural research can expect to reach that goal.

Statistical methods applicable to biological research are described in an ever-increasing number of publications. The following selected list gives titles of some of them:

FISHER, R. A.
1946 (10th edition). *Statistical Methods for Research Workers.* Oliver and Boyd, London.

1949 (5th edition). *The Design of Experiments.* Oliver and Boyd, London.

SCHUMACHER, F. X. and CHAPMAN, R. A.
1948 *Sampling Methods in Forestry and Range Management.* Duke University, School of Forestry, Durham, North Carolina, U. S. A., Bulletin 7.

SNEDECOR, G. W.
1946 (4th edition). *Statistical Methods Applied to Experiments in Agriculture and Biology.* Collegiate Press, Inc., Ames, Iowa, U. S. A.

YATES, FRANK
1949 *Sampling Methods for Censuses and Surveys.* Charles Griffin & Co., London.

The New Imperial Forestry Institute, University of Oxford

By H. G. CHAMPION

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ON 19 October 1950, Her Royal Highness Princess Margaret paid her official visit to Oxford to open the new Imperial Forestry Institute which will accommodate the University Department of Forestry and the Commonwealth Forestry Bureau, which is linked with it.

In her speech, the Princess referred particularly to the important part forests and afforestation play in checking soil erosion—as she saw in South Africa—and to the need for a close understanding between the forester, the farmer, the sportsman and, indeed, all who love the country to ensure that the woods and forests not only meet commercial requirements for timber, but also provide for more general use and enjoyment. Later she planted a yew tree in front of the building; this tree, a native evergreen providing a useful timber and symbolizing longevity and durability, was chosen as alone fulfilling all the requirements for the occasion.

A special exhibit in three of the laboratories demonstrated the great value of forests in protecting soil and crops against wind and water, in conserving and regulating water supply, and in yielding material essential to human welfare. The need for scientific silviculture and management to ensure the maintenance of the protective and productive values of the forest was illustrated with models, photographs, and diagrams; and the economic, engineering, utilization, and amenity aspects were also represented by a variety of exhibits. One of the rooms was largely devoted to showing the importance of research into the relationship between a tree and the soil on which it grows,

View of the new Imperial Forestry Institute at the University of Oxford.

a finding which is the objective of the Institute's main team-study at present. There were in addition ten sectional exhibits dealing with recent research work by the staff in silviculture, ecology, tree physiology, soil microbiology, soil mesofauna, chemical and physical properties of the soil, wood structure, mycology, entomology, and economics. About one thousand people visited the building and the exhibits.

Representatives of the Forest Services, Forest Colleges, and Forest Research Institutions of the Western European countries were invited, as well as a large number of persons engaged in forestry administration, practice, research, or education or connected with research in related fields such as timber use, horticulture, soil science, genetics, and many University members, particularly scientists.

The Institute is housed in a four-story stone building built on an H-shaped ground plan. It is linked by a common lecture theatre with the still incomplete Botany Department of similar plan. The ground floor provides for administrative offices, lecture rooms, and silviculture and pathology; the next floor for the Library and connected activities (including the Bureau), engineering, wood structure, and photographic and artist's work; and the top floor for management, mensuration, economics, and entomology, as well as for the team doing research work on the relationship between tree growth and soil. The basement contains well-equipped workshops, storage space, and other services. In all, there are nearly one hundred rooms of all sizes for a staff (including the Bureau) of 17 senior staff and 43 assistants, secretarial, technical, etc.

In furnishing the interior, timber has been used as much as possible. The Forest Departments and timber associations of practically every timber producing country in the Commonwealth have contributed timbers for the purpose. This has made it possible to provide an exceptionally fine display of timbers in use as paneling (ten rooms in different timbers), flooring (14 species), and furniture (30 species from all continents). Much of the general furnishing has also been carried out in these gift timbers, notably bench tops in Burma teak and Pakistan garjun (*Dipterocarpus turbinatus*), shelving in various timbers from Borneo, Trinidad, Nyasaland, British Columbia, and Nigeria. South Africa and Queensland have provided *Ocotea bullata* and *Endiandra palmerstonii* respectively for two of the most striking paneled rooms; the paneling and flooring of the entrance hall and main corridor are of *Betula lutea* and *Acer saccharum* from Canada.

A small area near the building has been allotted for the construction of glasshouses, etc., for experimental work, and the Institute has two relatively extensive blocks of woodland available within a few miles for practical instruction, one of them being directly under the technical management of the Department.

International Society of Tropical Foresters

IN Washington, D. C., U. S. A., on 14 December 1950, 24 foresters met to form the International Society of Tropical Foresters.

The primary purpose of the new organization is to keep tropical foresters in touch with others in their field and with the work they are doing. It will also serve as a clearinghouse of information on developments and opportunities in tropical forestry, as well as on recent additions to tropical forestry literature. It will be a repository of information on the location and fields of activity of men working in tropical forests or with tropical forest products. It is planned to keep the membership in touch with developments by means of occasional memoranda or news letters. In this way the organization should facilitate contact between qualified foresters and occupational opportunities.

Membership in the society is open to foresters of all nationalities working in all types of tropical forest products, including rubber. No dues are required, and those interested are urged to write Tom Gill, 1214 16th Street, N.W., Washington 6, D. C., U. S. A. Mr. Gill is Chairman of FAO's Technical Committee on Unexploited Forests.

Commodity Report

Softwood Lumber

This report is limited to the main trends in supply and demand in Europe and North America. The period covered is extended as far as possible into the fourth quarter of 1950.

THE softwood lumber supply and demand situation during the first half of 1950 was characterized by a high level of consumption. In many circles in Europe and North America it was thought that there would be a break in the predominantly seller's market during late summer or early fall, primarily as a result of seasonal factors. This development was delayed, however, by the outbreak of the Korean crisis, with the necessity for speeding up stockpiling purchases, and the implementation of European rearmament programs. Not until October was there a setback in certain lumber prices in North America, indicating that the pressing need for some grades of lumber, which prevailed earlier in the year, had disappeared. On the other hand, no such sudden change in the European situation could be noted.

In Europe, softwood lumber consumption rose steadily during the first three quarters of the year in most of the Western European countries. In the United Kingdom and the Federal Republic of Germany, however, consumption is still far below prewar.

In the United States and Canada, the firm demand for softwood lumber during the first nine months of the year made it possible to maintain a stable or strengthening trend in prices. This situation was bolstered by a freight-car shortage on the west coast of the United States during late summer and early fall. Thus when more cars became available at the beginning of the fourth quarter, some softening on the lumber market followed. Curtailment of housing credits and restrictions on some types of construction in the United States, resulting from the Korean crisis, began to affect the demand for lumber toward the end of the year.

As for international trade in softwood lumber, the trends described in our previous survey (UNASYLVA, Vol. IV, No. 3) were maintained for most of the period under review. Exports from Canada were mainly destined to the United States, and overseas shipments from these two countries remained relatively small. The European softwood lumber export trade, on the other hand, was expanding on all markets of importance other than France and the United Kingdom. Exports from seven of the main exporting countries* reached 841,0000 standards during the first half of 1950, as compared with 616,000 standards a year earlier. The British Timber Control, from the opening of the shipping season, resisted purchasing at prices demanded by Swedish exporters. As the season progressed, Swedish availabilities for the United Kingdom declined. In the long run, the United Kingdom's policy of waiting could not be maintained and, as the seriously depleted stocks of the country had to be built up later in the year, large contracts were placed in Canada at prices higher than the United Kingdom had originally intended to pay.

The European import requirements have so far not been met by any marked increase in supplies from the U.S.S.R. While it is likely — barring changes in the political situation — that exports of softwood lumber from the U.S.S.R. to Europe may be maintained at present levels or even increased during the next years, the U.S.S.R. will also import some lumber. The new Finno-Soviet trade agreement provides for certain exports of Finnish timber to the U.S.S.R. during a five-year period.

A somewhat confusing price situation prevailed at the beginning of the fourth quarter of 1950. In some European exporting countries the trend toward rising prices was very strong. In Sweden, in the October 1950 auctions organized by the state forest administration board, the prices for standing timber showed an average increase of 63 percent over 1949 prices. Although the major part of this rise was in pulpwood prices, the prices for sawlogs had also increased considerably. No certain indications were available at the time of writing as to the opening prices for 1951. The general European supply situation suggests a strengthening of prices for 1951. As, however, the dollar shortage has been partially alleviated, especially in the United Kingdom, it is likely that purchases from Canada and the United States could be increased to some extent, provided additional supplies are avail-

*Austria, Finland, France, western zones of Germany, Norway, Sweden, and Yugoslavia.

able from these sources. The weakening trend in Canadian lumber prices may therefore affect export prices for northern European lumber during 1951, yet the basic price for Swedish 7″ redwood battens, which averaged about £50 net f.o.b. per standard in 1950, is expected to rise to at least £60 net f.o.b. in 1951.

During its session in October 1950, the Timber Committee of the Economic Commission for Europe concluded that 1950 export supplies of sawn softwood from European sources, including the U.S.S.R., would run somewhere between 2,144,000 and 2,377,000 standards. Assuming that at least 285,000 standards would be shipped to Europe from the Western Hemisphere, i.e., Canada, the United States of America, and Brazil, the committee expected European import requirements for 1950 to be more or less completely met.

According to the Timber Committee, 1951 export supplies of softwood lumber from European sources, including the U.S.S.R., could be estimated at between 2,000,000 and 2,375,000 standards. The improved currency situation would possibly allow an increase in imports from the Western Hemisphere, tentatively estimated at 475,000 to 500,000 standards for 1951. Since European import requirements may exceed 3,300,000 standards, a gap of more than 400,000 to well over 800,000 standards could develop in the European supply/demand picture.

In certain European importing circles the prospects are viewed with a seriousness which has resulted in suggestions for the allocation of European timber trade. However, there are indications that additional quantities of North American lumber will be available and purchased by European importers before the United States defense program gets into high gear. By mid-November it was reported that the United Kingdom Timber Control had made contracts for well over 400,000 standards of Pacific Coast timber for shipment before the end of June 1951, and that the shipment of about 850,000 standards from North America to the United Kingdom could be foreseen during the next twelve months. This would mean that in 1951 the United Kingdom alone would import from North America roughly three times as much softwood lumber as all Europe was expected to import from the Western Hemisphere during 1950.

In Canada the tentative "plan" for the construction of 606,000 dwelling units during the first postwar decade is considered as being less than a maximum program. It is therefore expected that the demand for housing will be strong for some years, provided that the national income remains at a high level and the government continues to encourage house building as a deliberate policy. According to Canadian estimates, a 50,000 unit per year building program would require some 363,000 standards of lumber, a 60,000 unit program about 436,000 standards, a 70,000 unit program 505,000 standards, and an 80,000 unit program 581,000 standards. These figures plus estimates for commercial and public construction indicate that the potential domestic demand for lumber will remain strong, barring unfavorable economic or political changes.

In the United States, demand for and production of softwood lumber for housing will depend to a great extent on the effects of the new mortgage curbs on construction activity. The present yearly level of some 1.4 million housing starts will no doubt be heavily curtailed but predictions for 1951 vary from a pessimistic forecast of 600,000 or 700,000 to some 800,000 or 900,000 new housing starts.

The effects of diminishing construction activity on the consumption of softwood lumber in the United States are expected to be counterbalanced by increased requirements for repair and modernization of homes, stores, farm buildings, and other structures, for defense purposes, and for packaging.

Europe

Consumption

In most European countries the first half of 1950 was characterized by a relatively high level of industrial production and, particularly in many Western European countries, by greater building activity. There was, in general, an increased need for timber. As the prospects for building and industrial activity were considered favorable, purchases of lumber from Northern European sources were started by the importers, with the exception of the United Kingdom, very early in the season. Even with rising prices, the demand for lumber remained firm, and markets showed some weakness only in France and Switzerland.

In *Austria*, building activity was affected by financial difficulties toward the middle of 1950. Consumption of softwood lumber for the first six months, however, was somewhat greater than during the corresponding period of 1949.

In the three northern exporting countries economic activity was, on the whole, comparatively brisk. In *Finland* both industrial production and construction activity increased during the first half of 1950, but were accompanied by inflationary symptoms. In *Sweden* industrial production was also high, and the construction of dwellings showed a rising tendency toward the end of the period. The same seemed to be true for *Norway*, which continued to be a net timber-importing country. There, however, the most urgent building needs appeared to be filled. The indications were that domestic consumption of softwood lumber in these three countries was relatively stable and tending to increase somewhat.

The situation in the *United Kingdom* was unlike that in other importing countries. In spite of large requirements, consumption declined during the second quarter of the year to a monthly average of less than 75,000 standards of imported sawn softwood and some 7,000 standards of home-grown softwood. Even these low levels put a heavy drain on stocks. The shortage of selected lengths and dimensions was, at times, very acute, resulting in temporary and local curtailments of construction activity, but, on the whole, the building activity of the country increased somewhat as compared with the first half year of 1949.

In the *Netherlands* there was a marked strengthening in demand for and consumption of softwood lumber during the first six months of 1950. This was caused by the rise in industrial production and by increased building activity. Taking into account a

decline in average consumption of timber per dwelling unit in the Netherlands from some 21 m^3 prewar to roughly 14 m^3 in the postwar period, it is estimated that the total timber consumption by the building trade during the first half of 1950 was almost equal to that of 1937.

In *France* and *Belgium* industrial production declined somewhat during the first half of 1950. The demand for lumber in France was not particularly active, in spite of some expansion of building operations. In Belgium, however, the growing need for softwood lumber was reflected in the country's increased imports.

In *Italy* intensified building operations led to strengthened demand for timber. In other fields, too, the consumption of softwood lumber was increased.

In *Switzerland*, also, the consumption of softwood lumber for construction purposes seemed to have increased, while the demand for second- and third-class boxboards and for inferior quality sawnwood was slackening.

The industrial production index in *Western Germany* showed an increase of about 12 percent from December 1949 to June 1950. The housing shortage is estimated at between 4 million and 5 million dwelling units, about half of which are required to replace buildings destroyed during the war, and the remainder for housing of postwar refugees. A total of 2,500 million marks was scheduled to be used for the government-sponsored housing program.

It was expected that 330,000 new dwelling units would be completed during 1950. Although no data on lumber consumption were available, it was believed that the consumption level in 1950 would be considerably higher than in 1949. The demand for softwood lumber was reflected by increased imports.

Production

For the first half of 1950 output of sawn softwood in Europe was estimated at about 3,954,000 standards, as compared with 3,884,000 standards during the corresponding period in 1949.

The increase in the production of softwood lumber was particularly large in *France*. The salvaging of timber damaged by earlier forest fires brought the output of sawn softwood in this country during the first six months of 1950 to 40 percent above the 1949 level. In *Austria*, the production of sawn softwood rose about 19 percent as compared with the corresponding period of 1949. Output of all sawn timber in *Finland* was almost 11 percent higher than a year before, and reports from *Sweden* also indicate a considerable increase. There were no marked changes in the output of sawn softwood in *Norway*, and production declined slightly in *Yugoslavia* and *Switzerland*. Output in the western zones of *Germany* dropped from 857,000 standards in 1949 to 793,000 standards in 1950, or over 7 percent.

Exports

Export trade on the softwood lumber market was very active from the beginning of the year. The position of the European exporting countries was favored not only by the early opening of the export markets with soaring prices and by the persistence of the seller's market but also by the effects of the Korean crisis, as well as by the absence of effective competition from non-European sources.

Although the most important lumber buyer, the United Kingdom, remained comparatively reluctant to make early purchases from the northern exporters at the relatively high prices prevailing at the beginning of the shipping season, *Finnish* sales had reached around 500,000 standards and *Swedish* sales some 425,000 standards by the end of the first quarter. The new seller's market had, by the end of the first half year, absorbed from 75 to 90 percent of the quantities available for export from the northern countries.

By the end of the first half of 1950, only about 100,000 standards of Finnish and less than 50,000 standards (a large portion being goods ordered in 1949) of Swedish sawn softwoods had been sold to the United Kingdom. The most active single buyer of Finnish and Swedish lumber during this period was the Netherlands, but increased quantities were also shipped to Denmark, Western Germany, and Belgium, as well as to the Union of South Africa and Australia. Sweden's lumber exports to Australia, which rose from 2,000 standards a year prewar to 25,000 standards in 1949, were believed likely to reach 50,000 standards in 1950. Finnish exporters were regaining markets in South America and in the Levant.

In July and August 1950 Finland's lumber export trade policy was revised. Licenses were no longer issued for shipments of lumber to Denmark and the Netherlands, since the contingencies reserved for sales of Finnish lumber to those two countries had been exceeded. A little later, it was announced that permits for new sales of lumber would be given only for shipments to the United Kingdom. This measure was motivated by Finland's great need for sterling. Under a new agreement Finnish exporters pledged to sell to the United Kingdom during 1950, at increased prices, 150,000 standards instead of the 107,000 standards remaining against the agreement made at the beginning of the year. It was estimated that some 60,000 standards would be delivered during 1950, leaving a balance of 90,000 standards for shipment at first open water in 1951. Total sales of Finnish lumber to the United Kingdom in 1950 were thus increased to 267,000 standards. Later, as a result of serious strikes in Finland, the quantity to be shipped during the 1950 season was reduced by 40,000 standards.

By the end of the first half year of 1950, exports of softwood lumber from Finland to the U.S.S.R. had slightly exceeded 8,000 standards, only about one-fourth of the 1949 quantity. In June 1950, however, a five-year trade agreement was concluded between the two countries, providing, inter alia, for an additional export of 10,000 standards to the U.S.S.R. during 1950 and of 60,000 standards annually during the four remaining years. An equivalent of a further 55,000 standards of sawn wood is represented by the wooden houses which Finland was scheduled to ship to the U.S.S.R. during 1950; in each of the following years covered by the agreement Finland's shipments of prefabricated houses to the U.S.S.R. will represent 80,000, 70,000, 70,000, 55,000, and 25,000 standards of sawn wood respectively.

By the beginning of September, Sweden was estimated to have exported about 600,000 standards, which suggested that the total exports of softwood

lumber during 1950 could reach a volume of around 700,000 standards (including some 50,000 standards of boxboards), as compared with a total of 648,000 standards (including some 43,000 standards of boxboards) in 1949. Shipments of Swedish lumber to the United Kingdom, however, were not expected to exceed 50,000 standards for the entire year 1950, as compared with 233,000 standards in 1949. Toward the end of the third quarter, the sending of some sample shipments of lumber to the United States was seriously contemplated in Swedish trade circles.

As a result of the favorable market, *Norway* more than doubled its exports of sawn softwood during the first half of 1950. In October 1950, exports of timber from Norway were stopped for the rest of the year. Domestic needs, particularly those of the building industry, had to be met, and the 25,000 standards scheduled for export in 1950 had been sold.

Austria's lumber exports during the first eight months of 1950 were reported to have reached a level roughly equivalent to prewar levels for twelve months. This was mainly due to the demand in Italy.

France's exports of sawn softwood, exceptionally large because of the availabilities resulting from the forest fires, exceeded the abnormally small amount imported during the same period. The bulk of the French exports went to the Near East and North Africa, and to the United Kingdom.

During the early part of 1950, the U.S.S.R. did not play a very active part in the softwood lumber export trade. Shipments under the 153,000-standards agreement concluded with the United Kingdom in June and mentioned in our previous report on softwood lumber, began in August when about 30,000 standards were sent. The U.S.S.R. took up the option, provided by the contract, for an additional 45,000 standards, thus bringing its total shipments to the United Kingdom for 1950 up to almost 200,000 standards. During the first half of 1950, shipments of softwood lumber from the U.S.S.R. to Belgium were about 4,500 standards, the total quantity contracted for 1950 delivery amounting at that time to 14,000 standards.

Imports

During the first six months of 1950, imports of the greatest buyer, the United Kingdom, declined roughly 33 percent, whereas imports of most continental countries increased, as compared to 1949. The net result was an increase of about 7 percent over total European imports during the first half of 1949.

The increase in the import figure for the first six months of 1950 was entirely accounted for by imports from European sources. Imports from the dollar area did not reach 44,000 standards, a decline of more than 50 percent from the levels during the corresponding period in 1949. Later in the year, the allocation of ECA (Economic Cooperation Administration) dollars for purchases of timber was discontinued, and timber imports from the dollar area were thus made dependent upon "free" dollar availabilities.

As has been mentioned earlier, the *United Kingdom's* reluctance to purchase on a rising market was responsible for the low level of its lumber imports during the first half of 1950. The results of this policy were manifold. By the end of June 1950, the United Kingdom's imports from Sweden were only a little more than 50,000 standards (over 54,000 standards during the first half of 1949) and those from Finland about 34,000 standards (nearly 32,000 standards in January-June 1949), while at the same time imports from Canada remained at less than 24,000 standards (almost 76,500 standards in January-June 1949); imports from the United States had dropped to the negligible level of 1,800 standards (6,000 standards a year earlier). There was an additional decline in imports from Yugoslavia, and a complete stoppage of shipments from Western Germany The increases in imports from France, Poland, and some other sources could only partially fill the gap existing between requirements and supplies. Consequently, stocks had to be drawn upon so heavily that they dropped from 415,500 standards at the turn of the year to only 170,200 standards at the end of the first half-year period.

In the meantime, a surplus was developing with the dollar countries. This situation resulted in increased purchases of Pacific Coast lumber. By mid-September, contracts placed by the British Timber Control with exporters in British Columbia, Canada, and some sellers on the United States west coast totaled around 245,000 standards for shipment up to the end of June 1951. Additional contracts for shipments from dollar sources were placed in October.

The serious criticisms arising from the import policy of the British Timber Control during the first half of 1950 contributed to the decision regarding partial removal of timber trade control. At the beginning of October, the Board of Trade announced that softwood and mining timber purchases which had been under government control since 1939, could be concluded by private trade channels with Sweden, Finland, France, Austria, and other soft-currency countries for shipments arriving on or after 1 January 1951. The Timber Control will continue to buy in hard-currency areas and will also be responsible for importation from Eastern European countries, i.e., the U.S.S.R., Eastern Germany, Poland, Czechoslovakia, Yugoslavia, and Rumania. The new provisions did not relax existing controls over the use of softwood, but controls over home market retail prices of imported softwood will be removed as of 1 April 1951.

It was expected that the partial relaxation of the United Kingdom softwood import controls would result in greater purchases of lumber from Sweden and Finland for shipment during the early months of 1951 than was the case a year before.

By the beginning of November 1950, it was reported that the United Kingdom Government had already purchased about 600,000 standards for 1951 shipment. At that time, contracts made by private importers for shipment after 1 January 1951, did not exceed 9,000 standards.

The *Netherlands* played an outstanding role among the continental European importing countries which made sizable purchases of lumber for early delivery during 1950. By the end of the first half year, its imports had reached about 146,000 standards, more than a 50 percent increase over the corresponding period in 1949. Imports from Sweden and Finland, accounting for over 47 and 26 percent of the total respectively, had considerably increased, as had shipments from Austria. On the other hand, imports from

Western Germany, which totaled more than 105,000 standards, during the first six months of 1949, were now only about 10,000 standards, while imports from Poland, Czechoslovakia, and Yugoslavia had declined to a smaller degree. No imports from the U.S.S.R. were reported, against nearly 19,000 standards during the first half of 1949. By the latter part of 1950, purchases contracted by importers in the Netherlands for delivery during the year totaled about 395,000 standards, which was believed to correspond more or less closely to the whole year's imports of sawn softwood (against 325,000 standards in 1949). Some 48 percent of this total was accounted for by Swedish contracts, about 34 percent by Finnish contracts, and 9 percent by Austrian contracts.

Belgium, competing with the Netherlands for favorite dimensions and early deliveries, imported during the first half of 1950 about 56,400 standards, a quantity 71 percent higher than that of the corresponding period in 1949. Imports from Sweden, which represented almost 60 percent of the total during the first half of 1949, dropped slightly and accounted for only 33 percent of the total. The proportion of Finnish lumber, on the other hand, was more than trebled and represented almost 25 percent of the total. Imports from Canada were considerably increased, but did not exceed 2,700 standards; imports from the U.S.S.R. were 4,400 standards, and those from Western Germany 2,400 standards. By the beginning of the second half of the year, purchases from the U.S.S.R. for 1950 delivery amounted to 14,000 standards.

Denmark also increased its imports to a remarkable degree during the first half of the year — from 27,600 standards in 1949 to 58,200 standards in 1950. By early purchases, made mainly in Finland and Sweden, Denmark secured the bulk of its 1950 needs. Stocks showed a remarkable rise, and no large imports were expected during the last six months of the year.

Western Germany was a more important lumber importer during the first six months of 1950 than it had been earlier in the postwar period. While total imports of softwood lumber to Western Germany in 1949 amounted to 82,000 standards, imports during the first half of 1950 alone were almost 46,500 standards. By the end of June, imports of lumber into Western Germany from Sweden had reached 31,000 standards (less than 16,500 standards during the first half of 1949) and those from Finland almost 13,000 standards (nearly nonexistent during the first half of 1949).

Imports into *Italy* during the first six months of 1950 showed an increase of almost 19 percent over those for the corresponding period of 1949. The main source of supplies was Austria, which accounted for nearly 86 percent of total Italian imports of softwood lumber. With imports amounting to 92,000 standards during the first half year of 1950, against close to 78,000 standards a year earlier, the demand in Italy was well met and stocks were abundant.

Imports of softwood lumber into *Ireland* were also increased during the first half of 1950, and some timber-exporting countries, particularly *Sweden* and *Norway*, imported larger quantities than a year earlier. There was a marked drop, however, in imports into *France*. With reduced imports from Western Germany, total imports of sawn softwood into France did not reach 27,000 standards, against more than 43,000 standards a year earlier. The decline of softwood log imports, almost exclusively originating in the French Zone of Germany, was still more drastic, more than than 80 percent.

Prices

During the second and third quarters of 1950, there was a general strengthening in European softwood lumber prices, although there was no uniform price level. Prices were mainly influenced by three factors: the early purchasing activity shown by importers of Swedish and Finnish lumber; the upward trend in prices prevailing in the United States and Canada for the first nine months of the year; and, after the outbreak of the Korean crisis, the need for building inventories in a number of countries and for implementing rearmament plans.

In our last softwood lumber report, it was mentioned that Swedish shippers had sold to markets outside the United Kingdom at prices corresponding to a basis of £51 or more for 7″ u/s redwood battens net f.o.b. According to later reports, prices of first-class Swedish wood in the latter part of September climbed to £57 for 6″ u/s redwood battens, £68 10*s.* for 9″ u/s redwood deals, £52 and £58 respectively for fifths. The prices for u/s redwood boards at the same time were exceptionally high. Thus, a basic price of £73 was paid for 1″ x 7″, with an additional £7 for 1¼″ x 7″ or 1½″ x 7″ sidings. Also, prices for "utskott" were rising, and £40 to £41 were paid for this quality. Australia was reported to have paid a basic price of £55 for Swedish 7″ u/s whitewood battens and £42 10*s.* for "utskott" sold for delivery in 1951.

The basic price for Swedish 7″ u/s redwood battens in sales to the United Kingdom increased from about £13 per standard just prior to the outbreak of the second World War to £49, or slightly more, in 1950— both net f.o.b. Converted from corresponding amounts in Swedish kronor at the exchange rate current at the respective periods, the rise can be expressed in U. S. dollars as corresponding to an increase from about $60 to about $150.

The new arrangement made between Finnish exporters and the British Timber Control in the summer of 1950, and mentioned earlier in this report, provided for some increase in prices. Net f.o.b. basic prices were fixed as follows:

7″ u/s redwood battens	
Group I	£50
Group II	£49
Group III	£48
Group IV	£47
Group V	£46 10*s.*
Group VI	£46
7″ u/s whitewood battens	
Group I	£47 15*s.*
Group II	£47
Group III	£46 5*s.*
Group IV	£45 10*s.*
"utskott," 6″ and upwards	
Groups I-II	£34
Groups III-IV	£33
Groups V-VI	£32 10*s.*
Schaalboards	£32 10*s.*

In April 1950 the basic price agreed by Timber Control with the Finnish exporters for Group IV, 7″

u/s redwood battens, was £44, £3 lower than the new price; the April price for Group V was £43 5*s*., and that for Group VI £42 15*s*. In May 1950 the Timber Control had offered £47 10*s*. for Group I, 7" u/s redwood battens, as compared with the new price of £50.

The contract made between the British Timber Control and the three largest exporters in British Columbia, Canada, regarding shipment of about 135,000 standards up to the end of June 1951, is reported to have provided for an increase of about 5 percent over prices paid by the United Kingdom for Canadian lumber contracted in July 1950. The new contract is thus based on an equivalent of about £57 f.o.b. Pacific ports for Douglas fir merchantable quality which is most nearly comparable to redwood fifths from the best Swedish and Finnish mills. It was estimated that, under prevailing increased freight rates, this price would correspond to something near £75 c.i.f. British port. Later, in October 1950, the Timber Control was able to make new contracts for shipments from British Columbia at considerably lower prices.

At the beginning of November 1950 an increased export charge was imposed on all sawn and planed wood to be exported from Sweden in 1951. The export charge was reported to be anywhere from 50 Swedish kronor (about £3 6*s*. 8*d*.) to approximately 65 Swedish kronor (about £4 6*s*. 8*d*.) per standard. At the time of writing, it was not yet clear to what extent the export prices for Swedish lumber would be affected by the new charge.

North America

Canada

Consumption

In a report known as the "Curtis Report on Housing," Canada's housing needs for the first postwar decade were estimated at 606,000 dwelling units, which is considered a rather conservative figure. During the period from 1945 to the end of the first quarter of 1950 inclusive, a total of about 362,000 new dwelling units were built. The figure for 1949, 91,000 new units, was an unprecedented peak.

In spite of this development and a favorable trend in industrial activity as well, the consumption of lumber did not show any marked increases.

Production

According to estimates published by Canada's Department of Trade and Commerce, production of all lumber (excluding sawn sleepers) by all operators east of the Rockies, except those in Newfoundland, amounted to some 623,000 standards during the first half of 1950, which, compared to the corresponding figure of 690,000 standards for the first six months of 1949, would indicate a decrease of about 9.7 percent. Some 10 to 15 percent of the total is accounted for by hardwood. During the same period, production of softwood lumber and sleepers in British Columbia was estimated at about 729,000 standards as compared with 678,000 standards for the first half of 1949, an increase of 7.6 percent. Although the estimates for the eastern provinces and those for British Columbia are not entirely comparable, they suggest that no very remarkable changes in the output of softwood lumber in Canada had occurred during the first half year of 1950. In July 1950 there was a slight increase in the output of softwood lumber east of the Rockies, as compared with the preceding month, but at the same time there was a minor decrease in British Columbia.

Exports

Shipments of softwood lumber to the United States were exceptionally high during the first half of 1950, and preliminary estimates indicated an increase of approximately 130 percent. At the same time, exports to the United Kingdom represented only about one-tenth of the quantity exported to the United States, and exports to other markets were relatively small.

The larger contracts placed by the Timber Control of the United Kingdom with Canadian producers were scheduled to result in bigger export shipments later in the year and early in 1951.

Prices

Lumber prices in Canada have been affected by the firmness of the domestic market and the strong demand for lumber in the United States. It was reported that the increase in prices caused by exports from the Canadian west coast to the United States was felt as a disturbing factor in the domestic market toward the end of the summer. Buyers in eastern Canada became reluctant to buy western Canadian lumber for inventory, although there was a shortage of lumber in the east.

As of the beginning of October, the Canadian dollar was freed from its fixed rate of Can$1.10 = US$1.00 and left to find equilibrium with the United States dollar. The main effect of this measure on Canadian lumber exporters was expected to be a narrowing of the margin of "profit" which arose from soft currency devaluation in 1949. It was believed that the strengthening of the Canadian dollar might to some extent diminish the advantage of exports to the United States over domestic shipments.

United States of America

Consumption

Construction activity during the first half of 1950 remained unusually high and was estimated, in terms of new houses started, at 53 percent above the corresponding levels in 1949. Demand for lumber for all uses was exceptional throughout both the second and third quarters. Exports of softwood lumber during the first half of the year were about 5.5 percent above production, and gross stocks almost 17 percent below the figure of the previous year. But during the third quarter the situation changed; production increased more rapidly than the volume of exports and, therefore, stocks of softwood lumber were 4.1 percent higher than at the end of the previous quarter.

Consumption of softwood lumber during the second quarter of 1950 was almost 31 percent more than in the first quarter, and total consumption for the first half year set an unprecedented record, estimated at roughly 8 million standards.

From July through September 1950 construction activity and demand for lumber for building and industrial purposes continued on a high level. The defense measures called for by the outbreak of the Korean crisis resulted in increased consumption of lumber for packing and crating. Consumption of softwood lumber during the third quarter of the year reached an estimated quantity of about 4.75 million standards, thus bringing the total consumption figure for the first nine months of 1950 to roughly 12.95 million standards, as compared with 10.84 million standards a year earlier.

Controls on new construction and housing credit, issued during the third quarter of the year under the Defense Production Act, had an immediate effect on the volume of construction. There was a setback, and 6.3 percent fewer nonfarm dwelling units were started than in the previous quarter. Consumption, however, rose still higher during the third quarter, although at a much slower rate, and exceeded the previous quarter levels by 2.2 percent. It was thought that the consumption of softwood lumber during the last quarter of the year would drop by some 3.5 percent as compared with the previous quarter. Even so, consumption in 1950 would be about 14 percent higher than in 1949.

Production

Output of softwood lumber during the first quarter of 1950 lagged behind the volume for the last three months of 1949. During the second quarter of 1950, however, output reached a very high level, and the total quantity for the first half year was about 7.18 million standards, some 15 percent more than a year earlier.

Although the exceptionally high rate of production dropped slightly in July, production was on the whole relatively strong for the third quarter and rose to 4.6 percent above the second quarter record. By the beginning of the last quarter of the year, however, there were indications of a decline. It was reported that some small and marginal mills were closing because of price decreases.

Trade

Exports of all lumber declined during the first six months of 1950, owing to increased domestic demand. Exports of softwood lumber alone, totaling 84,800 standards, were almost 31 percent below the figure for the first half of 1949. Douglas fir lumber exports, representing about half of the total, had declined to approximately 50 percent of the previous year's figure.

During the third quarter of the year, exports were hampered not only by strong domestic demand and high prices, but also by increased freight rates and a continuing freight car shortage on the west coast. The total was approximately that of the previous quarter, and considerably below the exports of a year earlier.

On the other hand, imports of all lumber rose sharply during the first half of 1950. Softwood lumber imports, reaching a total volume of about 700,000 standards during this period, showed an increase of about 130 percent above the figure for the first six months of 1949. During the third quarter imports rose still further and were almost three times as large as during the corresponding period in 1949.

Prices

The Bureau of Labor statistics index for prices of composite construction lumber, converted to basis 1939 = 100, showed an all-time high of 333.7 during the second quarter of 1950. A relatively sharp increase occurred during the subsequent months, and the index rose to 371.0 in September. The index for Douglas fir lumber, for instance, rose from 384.7 in June to 415.4 in July.

The upward trend in lumber prices continued through September, but toward the beginning of October it was reported that prices for common grades of softwood lumber had begun to decline in several areas. Mill prices of Douglas fir and Western pine and hemlock, common grades used in home building, dropped $13 to $20 a standard from the record prices at mid-September. Prices of select grades of softwood lumber, however, remained firm.

Since the rise in lumber prices was brought about by a disruption of the distribution system, as well as by more normal factors, it was expected that an oversupply of lumber would develop toward the end of the year. At that time the freight car situation would be improved, and building operations would show a seasonal decline, aggravated by housing credit restrictions.

Locust Control

A report from a member of FAO's Agriculture Division indicates that in Central America locusts gather and breed in abandoned fields where the vegetation is short and scanty. To prevent locust outbreaks these areas must be put under intensive cultivation or a heavy vegetative cover should be established. When this is accomplished, it is hoped that locust parasites may be encouraged and that a better biological balance of hosts and parasites can be established. Some of the things which must be done to bring about this condition are afforestation, reforestation, prevention of overgrazing, and preservation of the existing forests.

Forest fires, which are very common and rather extensive throughout Central America during the dry season, may have a direct effect on locust outbreaks as the permanent breeding grounds of locusts are always found in relatively dry hills with very scanty vegetation. This is an additional reason for doing everything possible to prevent the uncontrolled occurrence of forest fires. Whenever fires are deemed necessary, from the agronomic point of view, the burnt areas should be put under cultivation or grazing should be limited and controlled so that vegetation may be re-established.

The Work of FAO

Special Session of the FAO Conference

THE last regular session of the FAO Conference in 1949 adopted the principle that future sessions should be held every two years but agreed that, if circumstances warranted, a session should also be held in 1950. A number of new developments soon began to have a profound influence on FAO's activities—the crisis in international relations in the Far East, the Expanded Technical Assistance Program, and the prospect of the removal of FAO headquarters from Washington to Rome. Because of these developments and the need for policy decisions on many budgetary and administrative matters, a special session of the FAO Conference was held at Washington 3-11 November 1950, preceded and followed by meetings of the 18-nation FAO Council.

Landmarks in Forestry Work

In his fifth annual report on the *Work of FAO, 1949/50*, prepared for the information of governments and the public, the Director General reviewed some outstanding achievements of the Organization's first five years of work, citing the following developments in forestry as important steps in the direction of FAO's objectives:

1. *Forest policy.* FAO has sought to have each country apply rational principles to its forest management, development, and utilization, and to base its activities on a national forest policy founded in law and soundly administered. Few countries have such a comprehensive policy. As a major undertaking, a statement of basic forestry principles is being put before the regional Forestry and Forest Products Commissions and then the FAO Conference for, it is hoped, adherence by all member nations.

2. *Forestry development in Europe.* The Copenhagen Conference (1946) considered the postwar needs of Europe to be the most urgent. The European Forestry and Forest Products Commission, the Timber Committee of the Economic Commission for Europe, and other European forestry bodies established or serviced by FAO since the Marianske-Lazne Conference (1947) have been instrumental in improving the situation in so far as forest products are concerned. The granting of loans for timber production equipment by the International Bank for Reconstruction and Development is an example of a successful project initiated by FAO.

3. *Forestry development in other regions.* The reports of the Teresopolis (1948) and Mysore (1949) Conferences are considered as charters for forestry activities in Latin America and the Far East. The Latin-American Forestry and Forest Products Commission, set up with headquarters at Rio de Janeiro, and the Asia and Pacific Commission, which held its first session at Bangkok in October 1950, now make it possible to extend the work of FAO to two of the most important forested regions of the world. A program for the Near East is under way.

4. *Montreal pulp conference.* This conference (1949), sponsored by FAO and the Canadian Government, was the first meeting to bring together important industry and government representatives from the major countries producing and consuming wood pulp. It allotted to FAO the task of keeping the wood pulp situation under continuous review.

5. *Forestry mission for Austria.* At the request of the Government, a mission has advised on the development and improvement of Austria's forest resources and industries. The mission's report is an example of a comprehensive investigation of the forestry and forest industries situation in a highly developed country.

6. *Improved forestry and forest products statistics.* FAO, as a regular part of its program, continues to publish and expand statistical series issued by various international bodies before World War II. Reviewed by special international meetings at Washington, Rome, and Geneva, the statistical program has led to a larger body of consistent and timely national statistics than has ever previously been available. These statistics are incorporated in the FAO report, *Forest Resources of the World*, in the *Yearbooks of Forest Products Statistics*, and in the ECE/FAO *Statistical Bulletins*.

7. *Basic forestry studies.* UNASYLVA, established in the early days of FAO, has been developed as a medium for discussion of problems of international concern. A new series of important and more intensive studies, basic to the Expanded Program of Technical Assistance, has been initiated—*Planning a National Forest Inventory* is published; *Forest Policy, Law, and Administration* is now in press; and others are being prepared.

8. *Technical consultations on forestry and forest products.* Among FAO's technical committees, the Wood Chemistry and the Mechanical Wood Technology Committees have achieved important results. Through its working arrangements with the International Union of Forest Research Organizations and the International Poplar Commission, its sponsorship of the Third World Forestry Congress, and its participation in the United Nations Conference on the Conservation and Utilization of Resources, FAO has done much to influence the direction of research and technical developments in many fields.

9. *Rational utilization of wood.* FAO's efforts to bring about more rational wood utilization and to standardize timber-testing methods, the sizes and quality of timber in international trade, and timber names should result in widespread improvements in these fields. The problems are difficult, but steady progress is being made, as evidenced by the results of the Mechanical Wood Technology Conference of 1949 and the technical meeting in Indochina in April 1950. The assembling of reference documentation on all types of modern mechanized forestry equipment is also a step toward encouraging rational development of forests and utilization of their products.

Factors That Will Shape the Future

In analyzing the present position of FAO in the light of recent world events, the Director-General said that the work of FAO in the past five years had been reasonably successful, but the conditions that were responsible for the setting up of FAO still exist, and they underlie violent stresses and strains within and among nations. A third of the world's people enjoy health, wealth, and well-being to a comparatively high degree; the other two-thirds live on intimate terms with poverty, hunger, disease, illiteracy, and premature death. These bitter contrasts break out in discontent and rebellion because—and this is the most significant development of our time—every day more people realize that such conditions are no longer necessary. Today there is not less but more need for the kind of work that FAO was set up to do.

By any standards of historical perspective, FAO is still very young. This is a time, however, when events move at such a pace that we cannot indulge in the luxury of leisurely development. Ex-

perience must of necessity be speeded up even at the risk of making some mistakes. The permanent staff of FAO has gained a fairly extensive experience during the past five years. But it has taken almost this long for FAO to become fully staffed, to train the staff in the viewpoints, attitudes, and kinds of activities required of an international organization, and to build up the intricate network of relationships with member governments and their national institutions and with other organizations carrying on work related to that of FAO, which is necessary for an effective job. Thus the organization is only now getting into its full stride.

The move to Rome, to be spread over the early months of 1951, will involve the separation from FAO's staff of a considerable number of highly trained professional people who find it impossible for one reason or another to make the transfer. At the same time, the world today is very different from the days of the Quebec Conference (1945), when FAO was created. It is split politically into two worlds, and economically there are difficult problems to overcome between hard- and soft-currency areas. The world is also far less stable than it was even a very short time ago. All this makes it advisable to re examine the functions and methods of the Organization.

Functions of FAO

The Special Session of the Conference, under the chairmanship of André Mayer of France, requested the Council to set up a working party of individual experts to consider, with the Director-General, the form and emphasis which the future activities of the Organization should be given, possibly including greater decentralization, more dependence on outside experts, and reorganization of the secretariat beyond that already contemplated by the Director-General. The recommendations of this working party will be examined at the next meeting of the FAO Council before being passed to the Sixth Session of the FAO Conference in November 1951, when the program of work and budget for 1952 and 1953 will be approved. In the meantime, the Conference authorized the Director-General to carry out a program of work in 1951 based on a total expenditure of $4.5 million and, if contributions from member governments exceed this sum, to undertake additional projects up to a total cost of $5 million. For the Division of Forestry and Forest Products this means largely a continuation of the program already outlined in *Unasylva*, Vol. IV, No. 2, 1950, on a budget reduced by 16 percent.

Technical Assistance

The Conference and Council heard and discussed a report by the Director-General on developments in FAO's participation in the Expanded Technical Assistance Program. It was noted that early progress had been limited by the fact that usable contributions to the Technical Assistance Fund had not yet been made by many countries, and because many of the recipient countries were not fully informed of the conditions under which technical assistance can be granted (See *Unasylva*, Vol. IV, No. 4, October-December 1950). Despite this, a number of satisfactory arrangements are being made, and the Conference expressed the hope that this program will serve to strengthen FAO's practical activities and its general authority in the realm of food, agriculture, forestry, and fisheries. All member countries were requested to collaborate in making available suitable technicians, equipment, and training facilities, and in undertaking the local responsibilities necessary to ensure that the rendering of assistance by FAO is fully effective and of continuing benefit. The Director-General was asked to give special attention, in the provision of technical assistance, to questions of land tenure and to problems of immigration and land settlement.

Commodity Problems

The Conference decided to continue the FAO Committee on Commodity Problems and to broaden its terms of reference, regarding it as the instrument of FAO to analyze and interpret the international commodity situations and to advise the Council on suitable courses of action.

International Plant Protection Convention

Final action on adoption of the proposed International Plant Protection Convention was put off until the 1951 session. Meanwhile, member governments were asked to submit amendments, and to give attention to establishing national and regional organizations for the protection of plants from insects and diseases.

Organization and Membership

Consequent on the move to Rome, the Conference decided that FAO's European Regional Office should be absorbed into the headquarters organization with effect from 1 May 1951, and at the same time to create a new North American Regional Office. The form which regional organization should take in Latin America was left to the Director-General's discretion.

The Conference extended the appointment of Norris E. Dodd as Director-General until the end of the next regular session of the Conference, and invited Lord Bruce to continue to serve as independent Chairman of the Council, but at his urgent request agreed to seek actively for a candidate to replace him as early as possible.

The Conference admitted to membership Cambodia, the German Federal Republic, Jordan, Spain, and Viet Nam, bringing the total membership of FAO to 66 nations, exclusive of Czechoslovakia and Poland, both of which have given formal notice of withdrawal from the Organization.

Latin-American Forestry and Forest Products Commission

THE Government of Chile was host to the third session of the Latin-American Forestry and Forest Products Commission at Santiago, 11-16 December 1950.

Previous sessions had been held at Rio de Janeiro, Brazil, and at Lima, Peru. This rotation of meeting places has enabled the functions and work of the Commission and the forestry activities of FAO generally to become widely known and understood in large areas of Latin America. For the future, the Commission has decided to reconvene once every two years, although it has empowered the Director-General to call special sessions should circumstances require. Between regular sessions, the continuous study of specific problems has been assigned to working parties of specialists.

At the opening meeting the members elected as Chairman the leader of the Chilean delegation, Victor Bianchi Gundian, Inspector of National Parks and Forest Reserves, Ministry of Lands and Colonization. Nations represented were Brazil, Chile, Cuba, Colombia, Dominican Republic, Ecuador, France, Nicaragua, United Kingdom, Uruguay, and the United States. Observers attended from the United Nations Economic Commission for Latin America (ECLA), the International Labour Organisation, and the Organization of American States (Pan-American Union). Marcel Leloup, Director of the Forestry and Forest Products Division, represented FAO headquarters, while the Chief of FAO's Latin-American Forestry Office acted as Secretary.

Forestry Principles

The Commission approved the principles contained in the special statement laid before it by the secretariat. This statement, prepared by FAO in keeping with a recommendation of the Third World Forestry Congress, has now been accepted by all three of the regional Forestry and Forest Products Commissions established by member nations of FAO. It will be submitted to the Sixth Session of the FAO Conference at Rome

in November 1951, for the purpose of securing formal support from all member nations.

For Latin America, the delegates considered that these principles should constitute the basis for the forest policy of each country, which must naturally be elaborated according to the special role of forests and forest products in the various national economies. It was remarked that technical assistance missions could suitably assist in laying the foundation for national forest policies, should recipient countries so desire.

Forest Research and Training Institute

The secretariat reported to the Commission on the latest developments concerning the project for a Latin-American Forest Research and Training Institute. An offer of collaboration made by the U. S. Government was noted with pleasure, and the Commission instructed the secretariat to maintain close relations with the Tropical Forest Experimental Station at Rio Piedras, Puerto Rico, on all problems of general interest.

As regards the project as a whole, FAO was asked to approach the several governments once more for an official statement of their intentions, a time limit of four months being set for replies. Where official proposals for establishing a regional station within a country can be immediately carried out, at least for certain types of research, the Commission requested FAO to furnish all possible assistance to that country in getting work started.

Standardization

Terminology. The Commission recognized with appreciation the past work of the Tropical Forest Experimental Station in Puerto Rico in preparing a Spanish-English glossary of forestry terminology. It was suggested that when the Station completes the definitions of 1,000 of the more important terms, the draft should be submitted to FAO, together with the 800 terms so far undefined, so that the glossary can be circulated to the different countries of the region for comment and addition of local synonyms. FAO is to arrange for the addition of synonyms in French, German, and Portuguese.

Forest types. A universal classification of forest types for Latin America, particularly of climax types, is greatly needed for the preparation of general maps of the region. The type classification developed by the Board for the American Tropics is considered the best, and should be adopted in forest surveys throughout the tropical areas. A similar classification for the temperate zones needs to be undertaken, and FAO was asked to investigate the possibility of assisting in this work.

Timber names. The Commission instructed the secretariat to continue its work of compiling standardized lists of timbers entering international trade, correlating vernacular, trade, and scientific names, in co-operation with governments and recognized taxonomic institutions.

Statistics. The secretariat was also instructed to co-operate with the Tropical Forest Experimental Station in Puerto Rico in finalizing the Spanish version of the terms used by FAO in forestry and forest products statistics. FAO is to add synonyms in English, French, German, and Portuguese. As regards the statistical programs of individual countries, the Commission recommended that furnishing statistical data on the production and trade of forest products should, within reasonable limits, be made compulsory by law. As the Commission had previously pointed out to governments, FAO can usefully furnish technical assistance to countries in connection with the development of national statistical services and the special training of statisticians.

Forest Development

Manpower and immigration. As it had done at a previous session, the Commission drew the attention of member governments to the importance of settlement and immigration as frequently presenting the only means of fostering forest development. It suggested that studies be undertaken of specific projects involving technical, economic, financial, or manpower difficulties which cannot be solved by governments acting alone but which are within the competence of international organizations. These studies should be referred to the ECLA Committee on Economic Development and Immigration, on which FAO, ILO, and other agencies interested in immigration are represented. The International Bank would also contribute in finding solutions.

The Commission considered that the concept of integrated forest industries, as advocated by FAO, constitutes the most desirable approach to forest development from all points of view. The nature and extent of the movement of manpower required would vary in different cases. It may proceed from surrounding areas of the same country, or from other countries. Its character will depend on the physical, climatic, and social conditions prevailing, and the nature of the manpower needs. In the temperate and subtropical zones, the Commission believed that immigration from European countries could have a far-reaching effect on forest development, to the benefit of European and Latin-American countries. In the tropical and equatorial zones, European immigration would be limited in extent; the problems of obtaining manpower adapted to the prevailing climatic conditions are quite complex. Intensive mechanization in such areas may be of particular importance in solving manpower shortages. Preparations for the settlement of new communities need the most careful study.

The whole matter will continue to receive the close attention of governments, of FAO, and of other agencies concerned. Special missions under the Expanded Technical Assistance Program will be called upon to carry out particular studies.

Chemical utilization. The Commission was of the opinion that chemical industries would in many circumstances present the only possibility of profitably utilizing many types of forest in the region, particularly the heterogeneous mixtures of tropical and temperate hardwoods. Several processes now offer theoretical solutions, having been developed in the laboratory or in pilot plants. Maximum use was urged of research facilities existing in Latin America and of the services of technicians already experienced in the particular problems involved. The Commission believed that FAO should consider the allocation of technical assistance funds for research into appropriate manufacturing processes.

Although it is difficult to foresee industrial requirements decades ahead, forest management and silvicultural methods should take full account of the prospects opened up by chemical utilization. Clearly, the need of wood pulp for paper manufacture is greatly in excess of production and is likely to remain so. Everything possible should therefore be done by foresters and industrialists to facilitate an expanded production.

Equipment. The Commission took note of the work carried out by the FAO secretariat in assembling information from manufacturers on modern equipment and machinery, and in passing on this information to interested parties. It urged continuation of this work, indicating that there is a special need for investigation of the ways in which equipment should be adapted to the conditions in tropical regions.

Technical Assistance

The main theme of many of the Commission's discussions was the Expanded Technical Assistance Program. Requests for assistance are steadily being received by the Director-General from countries in the region, and formal agreements have already been concluded with Guatemala, Haiti, Honduras, and Colombia. Other agreements are under negotiation with Brazil, Chile, and Mexico. Forestry experts have already accompanied FAO missions to Venezuela and Nicaragua, a United Nations' mission to Bolivia, and an International Bank mission to Uruguay.

The Commission urged all governments to take advantage of the expanded program, but stressed that, in all projects, due emphasis must be placed on sound forestry measures that ensure a continuous supply of raw materials while safeguarding the inherited forest wealth. The expansion of research in the various fields of forestry and forest products is essential.

Great importance was attached to the fact that recommendations of experts for forest development in ETAP projects must be accompanied by advice on suitable financing methods. The manner in which national financial resources can be utilized must be examined with the appropriate governmental agencies, and there is also a need for collaboration with ECLA, the International Bank, and other credit organizations.

Expanded Technical Assistance Program

As reported in our last issue, the first agreement under the Expanded Technical Assistance Program between FAO and a member government was signed in September 1950. It was an agreement to furnish an expert to the Government of *Burma* to advise on the possibility and suitability of setting up integrated forest industries. The highly qualified Austrian expert entrusted with this task recently arrived in Burma. He will make local investigations, formulate an over-all development program, and prepare detailed plans for the industries proposed. At the same time, FAO is arranging for two forest officers from Burma to study integrated forest industries in Northern Europe and North America.

Shortly after the agreement with Burma was signed, a second agreement was completed with the Government of *Guatemala,* to advise that country on problems connected with forest conservation, and soil and water conservation. Two experts have been designated. One—a French forester—took up his duties in Guatemala in mid-November 1950, after having been briefed at Headquarters in Washington. The second expert—a German entomologist—will shortly leave for Guatemala. He will be concerned mainly with the protection of the pine forests against insect pests. Both experts will also be responsible for the training of forest staffs and personnel.

The following are other Technical Assistance agreements which have recently been signed with Latin-American countries:

Colombia: The FAO program for Colombia is being organized under three separate agreements, one of which is still being negotiated with the Government. The program will involve the services of ten experts working in the fields of forestry, technical agriculture, and food and agricultural planning. The tasks of these experts are based in part on the recommendations of the recent International Bank Mission to Colombia. A Netherlands forestry expert will shortly take up his duties in Colombia, and prepare a preliminary basic survey of the forest economy of the country, with particular attention to conservation, management, and the economic utilization of the forest resource. He will investigate the role of forests in soil stabilization and conservation, and in the protection of watersheds, rangelands and farmlands. He will also take into consideration the need for the expansion of supplies of primary and secondary products for internal consumption and for the export trade of the country, and advise on the recruitment of further technical experts for the implementation of any developments the Government decides to undertake.

Honduras: This agreement provides for the services of four advisers in the fields of forestry, agricultural planning, supervised credit, and grain storage. This is part of a broad program of development by the Government for which assistance has also been sought from other international agencies. Honduras is a country rich in forest resources, consisting both of tropical hardwoods and extensive areas of pine. Honduras mahogany is a particularly valuable commodity, known in all the markets of the world. However, the existing system of agriculture is needlessly destroying forest areas. To help this situation, FAO is supplying a British forestry expert, who has just taken up his duties in Honduras. He will make an initial survey of the situation, with regard both to the needs of conservation and development for the forest resources and for the expansion of forest industries. He will also make specific recommendations for necessary legislative and other measures to implement the new national forest policy now under consideration by the Government.

Haiti: FAO is now assisting the Government of Haiti in carrying out certain of the recommendations of the United Nations' Mission to Haiti, in which FAO took part. The significance of forest areas for soil conservation and for providing local timber requirements was stressed in this report. The present agreement is designed to assist the Government in carrying out the particular recommendations made in this connection.

In the Far East, in addition to Burma, further Technical Assistance agreements have been signed as follows:

India: FAO will supply three forestry experts and arrange two travel fellowships. One of the fellows will study problems of organizing wood-working industries, while the other will be engaged in termite control studies. Experts to be supplied are a sawmilling technician having special experience in the layout, organization, and management of hardwood mills; a pulp engineer to investigate the possibilities of a new newsprint mill and to study the raw material supply situation; and a wood technologist to carry out research assignments at the Forest Products Research Institute at Dehra Dun.

Indonesia: On the basis of the report of an exploratory group of United Nations' experts who made a preliminary survey of Indonesia's needs for technical assistance, a comprehensive agreement was signed between the Government of Indonesia and several United Nations' agencies. This agreement provided for a number of long-term experts, of which FAO will supply one in the field of forestry and one in the field of agriculture. The special task of the forestry expert will be to advise on mechanical logging and extraction. He will also have to assist the Government in the planning of further technical assistance.

Ceylon: FAO has entered into an agreement with Ceylon to provide nine specialists to assist the Government in various phases of forestry, technical agriculture, and agricultural economics and statistics. Ceylon has had a highly efficient forestry organization for many years but the utilization of forest products could be considerably improved. The agreement provides for a forest engineer to advise the Forestry Department and to instruct local personnel in the best methods of conducting logging and extraction operations and in constructing forest roads, and a competent machinist to train local staff in research into the working qualities of local woods. A fellowship is provided for the training of a timber utilization research officer.

Thailand: The FAO Mission to Thailand in 1948 made a number of recommendations for developments based on a detailed examination of the country's economy. Close contact has since been maintained with the Government through the regional office of the Organization in Bangkok. One of the main concerns of the Government is that the country shall maintain the prosperity and comparatively high standard of living it has enjoyed for many years. Four forestry experts will give advice and assistance on forest management, plantation practices, forest surveys and sawmilling techniques, and train local personnel. Five forestry fellowships have been requested for the study of modern and improved methods of forest management, silviculture, and sawmilling.

Pakistan: Four experts are to be supplied for varying periods to help plan and organize a forestry development program: a logging expert with specialization in mechanical extraction methods to plan improved and mechanized economic exploitation of the tropical forests of the Chittagong Hill tracts in East Pakistan; an expert in the development of integrated forest industries, to advise on a more complete and integrated utilization of these forests; a sawmill expert to advise on the development of a processing unit for this area; and a medicinal plant chemist to study the chemical and economic properties of forest herbs and plants, and advise on methods of improving their yield.

It is also proposed to establish five fellowships for the training of national personnel for future employment in the over-all Pakistan forestry development program.

In *Europe,* a Technical Assistance agreement has been signed with *Austria.* The Austrian request for Technical Assistance in forestry stems from the report of the FAO Forestry Mission in 1950. That Mission recommended a broad program of forest rehabilitation, including reafforestation of some 300,000 hectares of cut-over land and the construction of forest roads and cableways for the logging of hitherto inaccessible areas. It also proposed large-scale capital investment for the modernization of Austrian forest industries. The ECA special mission to Austria co-operated fully in the preparation of this report and is

helping the Government to implement the recommendations contained in it. The Government of Austria has already established a Forestry Commission proposed by the Mission and, with the approval of ECA, has made large allocations towards the capital investments required for the modernization of its forest industries. It has now requested FAO to supply three forestry experts to assist in this program. The advisory services of two FAO technicians are desired on various phases of the forest development and investment program. The third expert is a sawmill technician to advise and train the country's technicians in plant modernization and efficiency, especially with a view to reduction of waste, increasing productive capacity, and reducing processing costs of sawmilling operations.

A number of other Technical Assistance Agreements are now under negotiation and are expected to be signed in the near future. They will be reported in later issues of UNASYLVA. The expanded Technical Assistance program of the Division of Forestry and Forest Products is in charge of D. Roy Cameron, latterly Chief of FAO's European Forestry office and Director of the ECE Timber Division.

REGIONAL TECHNICAL ASSISTANCE PROJECTS

Latin-American Pulp Research Laboratory

Besides its activities in the field of technical advice requested by individual countries, FAO is also considering regional Technical Assistance projects, the most important of which is for the carrying out of research in Brazil on the possibilities of manufacturing chemical pulp from heterogeneous mixtures of tropical species. Part of the funds for this purpose might be made available from contributions to the Technical Assistance funds. The services of a laboratory and pilot plant of the type required would be of direct use to all Latin-American countries, as well as to Brazil.

International Training Center on Prevention and Fighting of Forest Fires

In response to requests received from a number of countries, the U. S. Forest Service, the Economic Co-operation Administration, and FAO are giving consideration to the organization of courses in the United States, and possibly Canada, in the prevention and fighting of forest fires. It has been ascertained that some forty countries are interested in the project. In many countries proper protection against forest fires is one of the fundamental requirements for improved forest management, and FAO lays great stress on the importance of this regional project.

Asian Training Center for Lumber Graders

The Forestry and Forest Products Commission for Asia and the Pacific made a definite recommendation for a regional lumber graders' training course. The object will be to train inspectors in lumber grading, so that they may, on return to their own countries, pass on their knowledge and experience.

Asian Forest Research Institute

The Government of India has informally proposed that the Forest Research Institute at Dehra Dun should be developed to service member countries in that area. It is willing to provide facilities at the Institute for students and research workers from other countries in the region. This project is still in the preliminary stage.

Meetings

The following meetings with which the Division of Forestry and Forest Products is directly concerned, are scheduled for 1951:

- International Poplar Commission (Fifth Session), United Kingdom, 25 April-2 May.
- Second Conference on Mechanical Wood Technology, Austria, August.
- Land Utilization in Tropical Regions, Ceylon, August. (Postponed from 1950.)
- European Forestry and Forest Products Commission, Rome, September.
- Technical Committee on Wood Chemistry (Fifth meeting), New York, U.S.A., September.
- FAO Conference (Sixth Session), Rome, November.

Equipment News

The continual development of forest utilization and woodworking industries is reflected in the increasing demand for information on new equipment. For some time now, as recommended by the FAO Conference, the Division of Forestry and Forest Products has been collecting such information and supplying it on request to member nations. It is evident that there is sufficient interest to warrant the publication of a regular feature in Unasylva, *treating with new developments in nursery and reforestation, with forest fire fighting, construction and maintenance of haulage routes, felling and trimming of trees, haulage of timber, sawing, seasoning, and transportation of sawn timber, and other related fields.*

An inquiry directed to countries in which such equipment is manufactured or which had expressed a desire to be supplied with information, elicited general approval of this project, with the exception of one country. Since the chief value of the feature will lie in current reporting, data will be published as speedily as it becomes available.

Descriptions of equipment are based on information supplied by government services and manufacturing firms. FAO can assume no responsibility for any claims made by manufacturers All requests for further information should be directed to the addresses indicated.

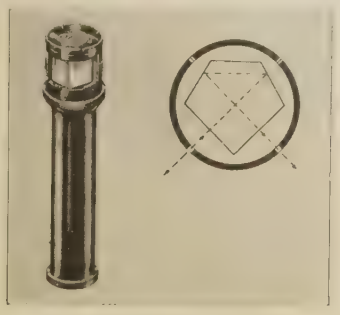
FAO's Division of Forestry and Forest Products will appreciate receiving data on new equipment manufactured anywhere in the world. Specifications should be accompanied by clear, sharp photographs (glossy prints). FAO, however, can accept no obligation to publish all such information received.

Bete G. 5 Fire Nozzle.—This new unit can be changed from full fog to straight stream or complete shut-off by a turn of the handle. It can be operated on any pressure from 30 to 150 lb.—using 8 gal. per minute for fog and 10 gal. per minute for straight stream.

Bete Fog Nozzle Inc., 85 Pierce street, Greenfield, Mass., U.S.A.

Fire-fighting Unit.—A unit which can be easily transported by two men, the weight being only 100 lb. This equipment consists of a new Pacific Marine "A" pumper weighing 36 lb. mounted on a pack frame, light weight accessories, 1-inch linen hose in knapsack, small suction hose, and enough mixed gasoline to supply the pumper for the ordinary small shore fire. Small ax, pulaski, and lady shovel complete the kit.

Photograph: United States Forest Service.

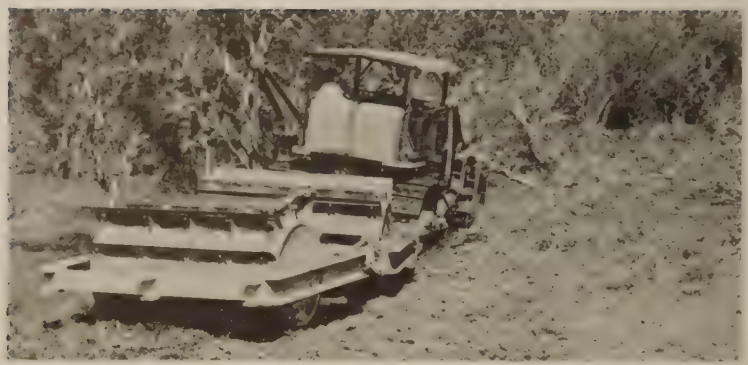


Pentaprisme Surveying Instrument.—Weighing 2½ oz.; height 4½ in. Lays out right angles rapidly. Permits quicker working than ordinary method with compass for 90° and its multiples. Gives an erect positive image.

Stratex Instrument Company, 1861 Hillhurst Ave., Los Angeles 27, Cal., U.S.A.

Harodite Canvas Relay.—This photograph shows a typical relay setup—canvas relay tank, 150 gal. (U.S.) capacity, pumper, and special gas container. Knapsack at extreme left contains a 300 gal. (U.S. canvas relay tank folded up for transporting to a fire.

Harodite Finishing Co., North Dighton, Mass., U.S.A.



MARDEN DUPLEX. — Although mainly used for farming, this tractor-drawn machine is also suitable for the construction and maintenance of firelines. It is effectively used in all places where a draw tractor can penetrate.

It consists of one or several cylinders weighted with water. The full-length, sharp blades staggered around the drum can cut branches up to 2 in. in diameter. An articulated yoke gives a great deal of flexibility to the machine and permits its use on any terrain. The very simple coupling system allows for the use of the drums either side by side or in tandem, according to the work to be performed. This machine is built in several designs.

Marden Manufacturing Co., Auburndale, Fla., U.S.A.

MICHIGAN TRACTOR FOR FOREST-FIRE CONTROL.— A tractor-tanker unit has been developed by the Michigan Department of Conservation at the Forest Fire Experiment Station, Roscommon, Mich., U.S.A. It is based on a wide-gauge crawler tractor, model AG-6. Mounted on the front of the tractor is an industrial model pump employing rubber rotors. The pump is assembled into a compact gear housing that develops proper pump speeds, and is driven by a front power take-off. The tractor driver can operate the pump at will by means of a selective clutch. A bumper and guard are installed at the front of the tractor.

Two 135-gal. tanks are mounted, one above each track frame. The entire tank assemblies are borne by the track frames, and no weight is attached to the tractor frame itself. The headlights are recessed into the bodies of the tanks. Features of the tanks include bolt-down tops permitting easy cleaning and interior maintenance; perforated pipes open at both ends of the tanks.

The left tank includes a live reel with a hose capacity of 100 feet; the rear of the right tank accommodates the battery. Valves permit the water to be circulated free of pressure within the tank systems, or to be passed under pressure into the live reel at will; the pump is thus primed at all times and ready for immediate use. Shut-off nozzle guns are used with this machine. The pump installation has been designed to permit pumping from the mounted tanks or from a tanker trailer towed behind the machine, or it may be employed for conventional line pumping. Pressures range up to 200 lb. and capacities range up to 40 gal. per minute.

Full tool equipment is contained in a sturdy tool box mounted on one tank; a tray on the right tank allows convenient access to shovel, ax, chain, or other accessories issued and used with crawler tractors.

The unit shown is the pilot model completed in May 1950 after almost two years of experimental development at the Forest Fire Experiment Station. The entire outfit can be manufactured in kit form ready for installation onto any crawler tractor.

Photograph: United States Forest Service.

HANNIBAL TRACTOR. — The Unipower Hannibal is a new four-wheel-drive timber tractor fitted with a crane at the rear of the chassis and a self-contained winch for forestry work. It has facilities for a fifth wheel attachment for special transport, such as trailers for heavy indivisible loads of up to 25 tons gross, and can also be adapted for shunting-yard duties.

The vehicle, powered by a five-cylinder oil engine, RAC rating 36.5 hp, has ten speeds forward and two reverse through a five-speed primary gear-box and a two-speed selective transfer case. The engine power is also used to operate the winch which can exert a pull of over 64,000 lb. A land anchor of heavy section steel is suitably located to prevent rearing when heavy timber is being roped. The winch is fully visible from the driver's seat.

In operation the anchor is lowered and the winch used to drag trees, etc., into any desired position. By means of an inclined ramp the trees can also be pulled onto a trailer. The cable is then detached from the tree, wound back on the winch, the land anchor is raised and the tractor used to tow the loaded trailer. The crane will lift lighter trees direct to the trailer.

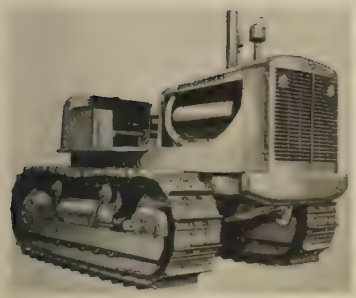
Universal Power Drives Ltd., Aintree Road, Perivale, Middlesex, England.

FLECO ROOT RAKE.— This rake is interchangeable with the moldboard on the bulldozer arrangement. It is used on general land clearing, clearing right of ways, etc., and is designed for use with the Caterpillar tractor.

Florida Land Clearing Equipment Co., Jacksonville, Fla., U.S.A.

COMBINATION MOLDBOARD.—This type of combination moldboard may be used either for land clearing or for dirt moving. With clearing teeth removed, the lower section of the dirt-moving blade slips into the teeth pockets and is secured in place.

Pacific Car and Foundry Co., (Carco), Renton, Wash., U.S.A.

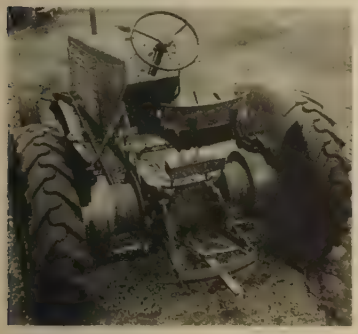


New Allis Chalmers HD 20-Diesel Tractor. — *Specifications:* general dimensions—over-all length, 15 ft. 10¾ in.; over-all height, 7 ft. 10 5/16 in.; over-all width, 9 ft. 1¼ in.; ground clearance, 16⅛ in.; shipping weight, approximately 41,800 lb.

Engine: General Motors Diesel—net engine h.p. at flywheel, 175; R.P.M. governed at full load, 1,700.

Speed and maximum drawbar pulls: low, 3.0 m.p.h., 65,000 lb.; high, 7.0 m.p.h., 32,000 lb.; reverse—standard, 5.5 m.p.h., 45,000 lb.; optional, 4.5 m.p.h., 61,500 lb.

Allis Chalmers Corp., Box 512, Milwaukee, Wis., U.S.A.



Heller Double Drum Tractor Winch.—The Oliver Corporation is in the process of equipping the 77 and 88 model tractors with a Heller double drum winch mounted on the rear axle, one on each side of the driver's cab. The specifications of the winch are as follows:

Cable drum length, 10 in.; cable barrel diameter, 8⅝ in.

Pooling capacity of each drum, ⅜ in. cable—910 ft.; ½ in. cable—480 ft.; ⅝ in. cable—303 ft.; ¾ in. cable—220 ft.

Maximum line pull model 77, low speed, double drum—27,467 lb.; low-speed, single drum—13,733 lb. Maximum line pull model 88, low-speed, double drum—36,500 lb.; low-speed, single drum—18,250 lb.

Six speeds, one reverse.

Photograph: Oliver Corporation, Cleveland, Ohio, U.S.A.

Hydraulic Elevating Ram. — Rear view of trailer equipped with a hydraulic elevating ram which elevates the bolsters to an angle of 15 degrees.

By means of a single hand-operated hydraulic pump and ram system the bolsters may be raised either together or each one independently as selected by the operator. They may be tilted to either side as required. When the bolsters reach an angle of 10 degrees the stakes on the side to which it is to be dumped automatically trip, discharging the load.

Equipped with two pumps, the operator works on the side opposite to that which the load discharges, thereby minimizing the possibility of accident as a result of logs falling on the operator.

Dominion Truck Equipment Co., Ltd., Kitchener, Ont., Canada.

New Hyster 78 Logging Arch.—This new arch has been materially reduced in weight as compared with the older model. Another advantage of the new logging tool is its increase of approximately one foot in roll height to the top of the main roll, allowing bigger payloads per truck. It is especially designed for use with Caterpillar D7 and D8 truck type tractors. Also shown on cover.

Hyster Co., 2902 N.E. Clackamas Street, Portland 8, Ore., U.S.A.

Ross Hydraulic Fork Lift Truck Series 24: maximum load, 26,000 lb.; lifting height, 14 ft.; turning radius, 17 ft. 6 in.; 4 speeds forward and reverse; weight 31,000 lb.

The Ross Carrier Co., Benton Harbor, Mich., U.S.A.

Steel Strapping for Saw Logs.—For transport convenience saw logs are bound with steel strapping ranging to 2 x .050 in. The strapping is tensioned and sealed around the packages by means of two simple tools, namely a stretcher and a sealer.

Acme Steel Co., 2840 Archer Ave., Chicago 8, Ill., U.S.A.

FOUR-WHEEL-DRIVE FOUR WHEELER.—*Engine:* six-cylinder Diesel—Meadows G.D.C. 630; Maximum torque, 420 at 1,000 RPM at sea level; B.H.P., 130 at 1,900 RPM at sea level; 6 forward speeds and reverse.

Chassis dimensions: wheelbase, 168 in.; over-all length of chassis, 228½ in.; over-all width of chassis, 104 in.; over-all height, 111 in.

Gross vehicle weight, 44,800 lb. maximum.

Load capacity 15 tons.

Tires: front — 36.00x8 — 40.00x8 — 8.25x20 — 10.00x20 — 11.00x20 — 11.00 x24 — 12.00x24; rear twins — 36.00x8 - 40.00x8 — 10.00x20 — 11.00x20 — 11.00 x24 — 12.00x24; single — 14.00x16 — 14.00x20 — 16.00x20.

Scammel Lorries Ltd., Watford, Herts., England.

TRAILER FOR HAULING PULPWOOD.—Illustrates a 30-ton trailer for hauling pulpwood.

The bolster stakes are released by the tripping of the chain held in place by dogs at the rear of the trailer.

Dominion Truck Equipment Co., Ltd., Kitchener, Ont., Canada.

HYDRAULIC TRUCK CRANE.—Hydra-Lift can be easily installed on any type of truck and used with any make winch. The truck driver can control all swinging and lifting from his cab. The boom swings in a 180-degree arc, lift 100 degrees. It can be used for straight-line pull and to load and unload off the truck bed.

The boom can be easily telescoped from 12 ft. to 17 ft. or 22 ft.; capacity varies from 6,400 lb. with boom at 12 ft. to 2,200 lb. with boom at 22 ft. Hydra-Lift takes up 37 in. behind the cab allowing full use of truck bed. It can be installed on any type truck frame with a few bolts.

Pitman Manufacturing Co., 300 West 79th Terrace, Kansas City, Mo., U.S.A.

R. B. LUMBER ROLLER BED.—Truck equipped with an R. B. lumber roller bed. Rollers may be kept locked or unlocked according to requirements. A ratchet crank applies to either end of any roller and half or all the load can be rolled off.

This device is especially used when vehicles are loaded with sawn timber.

The R. B. Co., Guinotte and Euclid Ave., Kansas City, Mo., U.S.A.

News of the World

The items appearing here are condensed selections of news thought to be of interest to readers of UNASLYVA. *They are grouped alphabetically by countries under headings currently used by the Division of Forestry and Forest Products for reference purposes. The Editor will be glad to receive direct from readers authenticated items of interest and of news value for this part of the review.*

General

GERMANY

• The *Forstarchiv*, oldest German forestry periodical and for twenty-five years the chief European reference organ for forestry and forest products, has resumed publication after an interruption of five years. The first number contains scientific papers on current forestry problems with relation to the research work done in Germany during the last ten years; a "sketch for the forestry education of a young friend," written by Goethe in 1807; a list of the research institutes, professional schools, and libraries connected with forestry and forest products in Germany, Austria, and Switzerland, as of April 1950; a tabulation on forestry data in Germany in 1927, 1936, 1946, and 1949; and a survey of the German publications of recent years.

Fundamental Science

CANADA

• A promising method of site classification based primarily on soil moisture and permeability relationships was tested under field conditions in the Nipigon area of Ontario by the federal Forestry Branch. This concept of site classification was originally developed by the Ontario Department of Lands and Forests. The work is being continued by the Ontario forest service in conjunction with the work of mapping the soils of the province.

In Quebec, field studies are almost completed on a system of site classification for the boreal forest; this classification uses the lesser vegetation and soil type as an index.

A soil map and study of the soils of the Kananaskis Forest Experiment Station in the subalpine section of Alberta have been completed and will provide a sound basis for future site studies in that area.

Silviculture

AUSTRALIA

• It has long been recognized that silvicultural treatment of plantations has an important bearing on the technical qualities of the wood. Many studies have been made using standard-sized specimens to determine this relationship, but the results have not been completely satisfactory. The Division of Forest Products of the CSIRO has perfected a machine which makes it possible to test specimens 1/16 inch (1.6 mm.) wide and only 3/1,000 inch (0.08 mm.) thick, prepared by slicing on a microtome. Thus, it is now possible to test wood produced during any particular period of treatment and to relate more precisely the effect of the treatment on the strength of the wood. Results to date indicate that this microtensile testing technique is extremely sensitive and it is hoped that valuable results will be obtained.

CEYLON

• In dry mixed evergreen forests the poisoning of undesirable trees by frill girdling, in order to free valuable species, is being replaced in part by felling such species and converting them into split firewood for sale. This serves to increase the amount of usable wood. It has helped reduce the price of firewood to urban consumers by one-third; it has increased revenue collection considerably; and it has substantially reduced the amount of trespass to obtain firewood.

UNION OF SOVIET SOCIALIST REPUBLICS

• In the far north, where the vegetative period is short, any measure is welcome that helps to prolong it. One of such measures practiced in the Yakut Republic of Asia is to sprinkle the snow in late winter with ashes, soot, road sweepings, or any other dark-colored powdered substance. This snow thaws much faster than white snow, due to the fact that, while white snow reflects nearly 100 percent of the sun's heat rays, a black surface absorbs nearly all of them. The following observations are cited as an illustration: On 19 April experimental plots were still covered with snow to a depth of 60 centimeters. On that date some of the plots were sprinkled with a mixture of ashes and soot. Three days later, on 22 April, measurements showed that on the blackened plots the snow depth was reduced by 35 centimeters but by only 3 centimeters on the untreated plots. On 26 April the snow on the blackened plots had disappeared completely, while on the control plots the snow was still 47 centimeters deep. On 8 May the ground on the blackened plot thawed out to a depth of 30 centimeters and green grass began to appear, while the surrounding country was still covered with snow 20 centimeters deep. Flowers appeared on the treated plots 11 days earlier than on the control plots. Cultivated fields when treated in this manner yielded 400 to 500 kilograms per hectare more because of the longer growing season.

For forest planting, baring the ground of snow earlier in the spring offers more moisture in the soil and better weather for planting. On the average, areas on which the snow has been sprinkled with some dark substance may have a 15 days longer growing season, not a small consideration in regions where the growing season is extremely short. The cost is nominal. From 100 to 200 kilograms of blackening substance per hectare is considered sufficient. Ashes, crushed charcoal, etc., are not hard to obtain and their application is simple. In the case of a late snowfall, the process may have to be repeated.

• Douglas fir (*Pseudotsuga taxifolia*) was introduced from the United States of America into Transcarpathia and the western provinces of Ukraine about 1880. Recent examination of these early plantations indicates that the species is very well adapted to the climate and soils of western Ukraine. The trees have made excellent growth over large areas when planted at elevations ranging from 50 to 1,000 meters above sea level. In plantations 42 to 53 years of age the trees had reached an average height of about 30 m., a diameter of 30 cm., and a timber content of between 500 and 800 m^3 per hectare—a growth comparable only to the European larch (*Larix decidua*). Tests of the physical and mechanical qualities of Douglas fir wood in these plantations showed—as regards weight, compression, and hardness—a close resemblance to those of fir, spruce, pine, and larch. On the strength of this evidence it is now planned to widely extend the planting of Douglas fir in shelterbelts, parks, etc., for timber

production. The seed is to be obtained from existing plantations, which are being held in reserve for seed production.

Logging and Engineering

Canada

• Experiments carried out during the past year in the prairie provinces on the use of rubber-wheeled tractors for towing sawlogs over long distances on sleighs, have met with considerable success; the transportation of logs on rubber-wheeled semitrailers in double-log or tree lengths has also worked well. The transport of timber over considerable distances to a central point for manufacture will permit more efficient milling practices.

Forest Injuries and Protection

Canada

• Perhaps the most important contribution in the field of forest fire research by the federal Forestry Branch during 1949 was the publication, in outline form, of a method for determining standards of acceptable forest-fire protection, adapted to the various forest regions of Canada. By this method, the average annual burning rate is used as a measure of the effectiveness of forest-fire control in each of the principal types of forest and wild land and in zones for which different levels of intensity of protection are required. The formula used to determine the acceptable burning rate for each class takes into account both the values requiring protection and the factors which affect the difficulty of protection. A procedure has also been developed by which elapsed-time standards may be derived for carrying out fire-control operations, in order to keep the average area burned during a period of years within the required limit.

In co-operation with the New Brunswick Forest Service an analysis was completed in 1950, covering a nine-year period, of the occurrence and characteristics of forest fires in that province in relation to the computed degree of forest-fire danger prevailing at the time of each fire. The study showed that the Wright system of fire-danger measurement, as used in that province, is highly effective in differentiating between good and bad fire days. Its reliability lessens, however, in areas where weather stations are spaced more than 25 miles from a point where hazard index values are calculated. The analysis shows the relative fire load or degree of fire-control effort to be expected in each class of danger, and brings out seasonal variations in the nature of the fire-control problem.

United Kingdom

• The replanting of recently felled or burned coniferous woods and plantations is liable to result in serious trouble from the pine weevil (*Hylobius*) and from black pine beetles (*Hylastes*) which breed in the stumps of felled trees and attack newly planted trees. The British Forestry Commission has issued Leaflet No. 25 (revised 1949) giving general recommendations for determining the time interval which should elapse between felling or burning and replanting so as to eliminate the danger of attack. The leaflet also gives methods of trapping insects in near-by areas which may provide a source of attack on the newly replanted areas.

United States of America

• The disastrous fires of October 1947 in Maine showed the urgent need for improved organization and integration of forest fire control, not only in the State of Maine but also in the other northeastern states. One result was new legislation in Maine, centering authority in the State Forest Commissioner for forest fire-fighting activities around the organized towns. Another and even more important result was the organization of the Northeastern Interstate Forest Fire Protection Compact, and the selection of a former regional forester of the U.S. Forest Service as its executive secretary. The seven states in the northeastern region having ratified the compact, it is now in operation, and it is hoped that adjacent states in the United States and provinces of Canada may become party to it.

The purposes of the compact include establishment of a central agency to co-ordinate the services of member states and to perform common services for them, integration of plans to control forest fires, maintenance of adequate fire-fighting services, provision of mutual aid among states, and developing procedures to facilitate such aid. The Northeastern Forest Protection Commission, created by the compact, consists of three members from each state, including the state forester, a state legislator, and a representative of the governor. The Commission has powers to recommend measures for prevention and control of forest fires, to formulate and revise a fire control plan, to recommend research work needed, and to make its own inquiries on methods and practices resulting in better fire control. The compact obligates states to put into effect plans and measures recommended and to help other states in emergencies. It also provides that employees of an aiding state shall have the same powers and immunities as officers of the aided state, and establishes methods of reimbursement for aid. It is hoped that this regional compact may serve as a model for similar action elsewhere.

• In 1948 the Columbia River Basin had its worst flood since 1894. Practically all rivers in the basin were in flood, towns and cities suffered great damage, and fifty people drowned. Fields, homes, and crops were flooded for weeks. This state of affairs was largely caused by unusually heavy winter falls of snow and a late spring The weather stayed cold until mid-May of 1948 and then suddenly turned warm throughout the region. Normally the rise in temperature is gradual, and the snow on the low-lying areas melts sooner than on the higher mountain slopes, where it may stay as much as three weeks longer in forested areas than on bare slopes. At the time of the flood the high mountain forests, although losing their snow cover, were still holding back a considerable volume of water. It was quite obvious, however, that large stretches of mountain lands lacking forest cover were adding to the floods.

One of the major reasons for the lack of forest cover on the high mountain slopes was that fire after fire had for years swept through and denuded the forests of the Columbia River watershed. The upper basin had a million-acre (400,000 hectares) forest fire in 1865, and others in 1868 and 1899. Three and a half million acres (1,400,000 hectares) of forest burned in 1910. In the 31 national forests of the basin more than 5 million acres (2 million hectares)—11 percent of their total area—had been burned.

A fire in 1919 in the Clearwater River drainage had previously demonstrated what happens when the protective influence of trees has been removed. The spring flood peaks were 11 percent greater than before, and the badly needed summer flow was 32 percent less; also, the average spring peak flow came fourteen days earlier than before the fire. This variation in peaks was noted time and again in the various small watersheds of the Columbia River basin during the 1948 flood. The peak flood from damaged watersheds usually came earlier than from those which were undamaged, and the peaks were always higher; after high water the floods from the damaged areas dropped more rapidly than those from forested drainages.

It is estimated that some 78,000 tons of silt was carried by the Columbia River during the twenty-one days of the flood. Many of the streams cut their old channels deeper and wider, and sometimes developed entirely new channels. Much of the material eroded from the mountain channels was coarse gravel and boulders, which was dumped by the flood on roads, recreation areas, and fertile lands. This coarse material, together with old logs, had in some places been piled up to change the course of the streams; sometimes, when suddenly released, it destroyed roads and bridges. In one case the coarse sediment remained in the creek bed to a depth of 5 feet (1.5 meters), which means that similar floods in future will more readily overflow the river banks.

Even if the best watershed conditions had existed, this flood could not have been prevented. But the lands damaged by fire, poor logging practices, poor grazing practices, and sometimes by poorly built roads, contributed far more than their share to the catastrophe. The job now is to restore these damaged lands.

Union of Soviet Socialist Republics

• Elms are valuable trees, both because of their high quality wood and their decorative value in parks and along streets. Widely distributed in Europe, North America, and Asia, elms have one serious drawback: low resistance to the disease caused by fungus *Graphium ulmi*. It causes yellowing of the foliage, defoliation, and finally death of the tree. The Dutch elm disease, so called because it was first discovered in the Netherlands, has caused the death of many fine elm

groves and of many valuable individual specimens of large size and historical significance in Europe and the United States. There is no effective remedy to check the spread of the disease, and it remains a serious threat.

The Russians report that they have discovered a small-leaved elm which exhibits an extraordinary resistance to the disease. Not a single small-leaved elm was found with the disease, and when these trees were repeatedly infected with the fungus they readily shed the infection. This discovery led to crossing the small-leaved elm with other varieties, thus producing resistant hybrids. During 1946-49 a method was developed for propagating the small-leaved elm and its hybrids vegetatively by means of cuttings.

• By a decree of November 1949 the Ministry of Forestry advised all forest administrative units that they must have complete fire protection plans by 1951. The existing plans include: (1) preventive measures (disposal of brush, building of fire lanes); (2) detection of fires and warnings of dangerous fire conditions (airplane patrol, fire towers, meteorological observations, etc.); (3) fire suppression (fire fighting). The Ministry of Forestry, considering that these measures are treated as separate activities, believes they should be co-ordinated into a unified plan.

In addition to the regular fire protection, it is now proposed to bring silvicultural practices into fire protection and to use silvicultural methods to make the forests more resistant to fire. Several cases are cited to illustrate how proper silviculture can help minimize fire danger. In the northern coniferous zone, fires in pure pine and spruce stands travel through the tree tops (crown fires) and it is impossible to stop them. However, when these forests are cutover, the ensuing growth is aspen, birch, basswood (*Tilia grandifolia*), etc. By cutting clear wide strips through the pine and spruce and allowing the hardwood species to come up, it is possible to create wide barriers of fairly fire-resistant trees. These barriers may not stop the fires completely, but they do help to convert crown fires, which are impossible to fight, into ground fires, which are much more readily controlled.

Another example is provided by the forests in the prairie region. There, the fire danger rests in the grasses, especially the more readily inflammable species. As long as the forest canopy is kept dense, the grasses are shaded out, but, if the stands are allowed to open up, grasses encroach into the forest and may lead to crown fires. For proper protection the stands should always have a crown density above 0.7. In broad-leaved forests the purpose should be to eliminate all inflammable ground cover which has become established as the result of past fires, particularly the widely distributed heather. The amount of dry substance in heather in air-dry condition may amount to 8 tons and more per hectare, making this plant an important fire hazard. This can be combated by maintenance of very dense tree stands, introduction of shrubs which shade the ground, or any other operation that tends to cut off light from the ground.

Mensuration and Surveying

Canada

• During 1949/50, research in air photography by the Forestry Branch of the federal Department of Resources and Development covered problems in the following fields: biology, instruments, photogrammetry, films and filters, special forest photography, and mapping. Improvements are reported in the design of stereoscopes, plotting devices, the photoelectric planimeter, and the "moosehorn," an instrument for measuring crown closure in the field. Studies continue on improving the reliability of photographic estimates, on the relationship of basal area to crown closure, and on other problems in air surveying. Provincial forest services and industry have reported greater use in their forest surveys of the large-scale forestry tri-camera technique developed by the Forestry Branch. Instruction in this technique is given by trained personnel of the federal service.

United States of America

• A method has been developed in the Pacific Northwest for estimating forest area and volumes of relatively large tracts measuring 36 square miles (93 km^2) and upward in size. First of all, a set of aerial photographs is made. Then, in the office, a tentative delineation of forest classes is made, based on timber types and forest condition classes. This tentative classification is checked in the field, particularly where the drawing of class lines is doubtful. At the same time, field work is done to locate the section corners, section lines, and bench marks needed to relate areas and volumes to ownership. The forest class map of the tract is then prepared and an area estimate is made of each forest class by placing over the air photograph a transparent grid of small, equally-spaced dots and the dots counted by forest classes. Next, the sample plots for volume determination are selected from the photographs, using random-choice methods. Then the photographs are taken into the field and a series of plots are laid out and measured around the selected point for sampling. In this way the volume per acre for each forest class is determined and total volume for the class may be readily worked out, depending on the acreage of that class on the tract.

Forest Management

Union of Soviet Socialist Republics

• In March 1950 the Ministry of Forestry put into effect directives as to the methods of cutting to be used in harvesting the principal timber crops. No such regulations were in force before, except for forests designated as "watershed protection forests," where no clear-cutting of any kind was allowed. The new regulations do not apply to mountainous forests but only to forests on comparatively level ground. The regulations cover pine, spruce, oak, and other broadleaf species (basswood, aspen, etc.,) in the four natural geographic zones—the prairie, the prairie-forest, the mixed forests, and the northern coniferous (taiga) zone. The rules vary somewhat according to the composition of the forest and its occurrence in one or another geographic zone, but certain principal features apply uniformly to all:

The silvicultural method of cutting adopted for all forests on level land is that of *clear-cutting*. The width of the clear-cut varies for pine forests from 50 to 100 meters according to their geographic location, for spruce 100 to 250 meters, for oak 100 meters, and for broadleaf softwood trees 250 to 500 meters. No timber adjoining the clear-cut strip can be cut until the logged area has been regenerated. The period allowed for regeneration is from two to five years. In the northern coniferous forests, regeneration of the cut-over area is to be accomplished by natural seeding, assisted by preliminary preparation of the ground, such as removal of the sphagnum moss or grass cover and stirring up the soil. In all other forests the regeneration is either artificial or natural or combination of the two. The slash must be disposed of immediately after logging. In pine and spruce forests the slash is burned in piles 1 to 1½ meters in height and diameter (150 to 200 piles per hectare). Where the ground is thin and rocky, however, the slash is not burned but broken up in small pieces less than 0.5 m. in length and scattered evenly over the area. The undergrowth, if it is of valuable species, is carefully preserved. No seed trees are left on the cut-over areas except in pine forests. Originally, 25 to 30 pine seed trees used to be left per hectare, but now the number has been reduced to 10 or 15 trees.

Marketing and Trade

Canada

• A pamphlet on the Christmas tree industry in Canada, issued by the Department of Resources and Development, shows that about 11 million trees were produced in the 1949/50 season, mostly for export to the United States. Balsam fir is preferred by most buyers, supplying almost half of the market. Other species chosen are Douglas fir, spruce, and Scots pine. The pamphlet concludes that the industry has a definite part to play in the social and economic life of the country. It is, furthermore, a profitable business: 50 to 60 Christmas trees can be raised in the time and space needed to grow one mature tree, and the stumpage value of the Christmas tree is at least four times that of the mature spruce. The present annual cut could be maintained in perpetuity on about 200 square miles (51,800 hectares) of forest land.

• The forest industries of Canada fall into five groups: operations in the woods, the lumber industry, the pulp and paper industry, the wood-using and the paper-using industries. The net value of production from operations in the woods amounted in 1948 to Can$461 million, 11 percent of the net value of all primary production. The net value of production in that year for the other four groups—the secondary forest industries

amounted to Can$916 million, almost one-sixth of the net value of all secondary production in Canada. The net value of production in all forest industries made up almost 15 percent of the total net value of all production for the year. During 1948, these industries employed over 381,000 men and women, more than 7 percent of the total civilian labor force.

Forest Products and their Utilization

Canada

• A barrel produced entirely from uniformly molded staves and a molded heading and bottom, has been developed at the Ottawa Forest Products Laboratory. Fully tested models have proved highly satisfactory. The staves are uniform in width and interchangeable. This feature permits the production of barrels that can be readily demounted for shipment and assembled at destination. A cooperage plant in eastern Canada is being equipped for the commercial production of these barrels.

• The use of a round-log gangsaw is gradually increasing in Canada, recent new installations having been made in Manitoba, Saskatchewan, and northern Ontario. This type of mill appears to be especially suitable for the manufacture of softwood lumber in the prairie provinces and in eastern Canada, where many of the logs are small and grade recovery is not of prime importance.

Morocco

• A plywood factory equipped with American machinery has started operation near Casablanca. The present monthly production of 300 m^3 of plywood board may be increased considerably in the future. The factory, the first of its kind in North Africa, will employ 100 workers and will use logs of mahogany and okoumé from Gabon, Cameroun, and the Ivory Coast, and native woods for the manufacture of crates and other items, mostly for local consumption. Scarcity of water in the factory area has led to the development of a special method to avoid the usual steam treatment of the wood strips.

United States of America

• The U.S. Forest Service is preparing a *Small Sawmill Operator's Manual* which will deal with mills ranging in size up to those cutting 20,000 board feet (50 m^3(s)) per eight-hour day. It will contain information on different types and designs of small machinery and equipment suited to small mills, their operation and efficiency, and their installation. The bulletin will also cover sawmill planning and direction, operational techniques, and man-hour and capital requirements.

• Tests on the effectiveness of various preservatives in protecting wood against marine-borer attack have been conducted for 29 years in Gulfport, Mississippi, and for 35 years in Pensacola, Florida, using both round southern pine piling and sawn sapwood pieces of standard sizes and with standard exposure. Some tests were made with modified wood and with untreated foreign woods which have natural resistance to marine-borer attack. The more important findings were:

(1) The most effective preservatives tested were higher boiling creosote oils and creosote fractions, higher-boiling water-gas-tar creosotes, and solutions of coal tar in coal-tar creosote. High-boiling creosotes are less toxic than low-boiling but have greater permanence in the wood. (2) Creosotes containing high percentages of light distillates or tar acids were far less effective than creosotes low in tar acids or high in tar bases. (3) Most effective treatments were obtained with heavy retentions and deep penetrations. (4) The resistance to attack was not improved when creosote was fortified with chemicals such as copper salts, organic or inorganic arsenic compounds, carbazole, dinitronaphthalene, dinitrochlorobenzene, ferric chloride, or high percentages of naphathalene. (5) Resistance of creosote was decreased by additions of paraffin of montan wax proportionately to the decrease in amount of creosote in mixture. (6) None of the large number of soluble and insoluble preservative salts used gave promise of protection for more than limited periods. (7) Petroleum oils gave little protection, and solutions of creosote and petroleum were less effective as the proportion of creosote was reduced. (8) *Limnoria* attacks treated wood that effectively resists shipworm (*Teredo*) attack. (9) Marine borers attack piling from the mudline to the water surface. (10) Variations in intensity of attack occur from year to year, and intensity is greatest during warm months. (11) Long-period experiments are necessary to obtain valid results. (12) Of foreign woods treated, greenheart resisted attack by both *Limnoria* and shipworm for a period of eleven years, manbarklak resisted for a short period, and other species were destroyed in relatively short periods. (13) Experiments of compreg modified wood were sound after four years of exposure, whereas impreg and papreg specimens showed attack during the same period. (14) Further work is desired on this problem and particularly the use of control series treated with coal-tar creosote as a means of comparing their life with that of specimens treated with other preservatives.

• The fertilizer requirements of the northeastern region of the United States amount to 1.7 million short tons (1.5 million metric tons) annually, and consumption is likely to continue to increase. On the other hand, the waste of wood material in lumbering, sawmill, and pulping operations reaches a figure of over 7 million tons annually. The Northeastern Wood Utilization Council, which was organized in 1942 for a concerted attack on problems of low-grade wood and wood waste, thus brings together summaries of applied research which may help to bridge the gap between waste and use. There are a number of practical possibilities for using wood waste, including use of wood ashes as a fertilizer, the use of sawdust shavings and superphosphate with dairy manure, the use of sawdust in lieu of wheat straw for bedding, the use of ground bark as a soil mulch, and the use of lignin as a potato fertilizer and as a soil builder. In all cases, the practical application of laboratory research is emphasized and, where available, the economical aspects of the use of wood waste are specified.

• Research at the Forest Products Laboratory, Madison, Wisconsin, on food-yeast production from wood-processing by-products shows that a food yeast high in protein and vitamins can be produced rapidly, with a yield of 40 to 45 percent of the wood substance from the carbohydrates in wood waste or in by-products from the chemical processing of wood. The sugars present in sulfite pulp waste liquor, which represent about 11 percent of the wood substance, are also suitable for food yeast production. The carbohydrates now wasted in alkaline pulping could be removed before pulping and used for production of food-yeast. Pentose and hexose sugars, obtained from wood, yield about equal quantities of yeast. For best yields and speed of propagation, yeast must be acclimatized to wood sugars, but continuous propagation is possible. A propagator has been developed to take advantage of foam that is normally a problem in the propagation of yeast from wood sugars. About 3.4 pounds of nitrogen, 1.6 pounds of phosphoric salts, and 1.1 pounds of potassium salts per 100 pounds of wood sugar (7.5 kg., 3.5 kg., 2.4 kg. respectively per 100 kg. of wood sugar) are required for maximum yields. Food yeast so produced contains about 50 percent protein, 4 percent fat, small amounts of vitamin B_1, and large amounts of vitamin B_2. The processes employed at the Forest Products Laboratory differ in some respects from the German process.

• The Unicel all-plywood combination refrigerator car and boxcar utilizes the entire car structure to absorb shocks, while the conventional steel freight car concentrates them in a center sill on which the whole framework of the car is placed. This distribution of stresses, which was first developed in Monocoque aircraft shells, reduces the maximum stress to about 3,000 pounds per square inch (200 kilograms per cm^2) while it reaches as high as 50,000 pounds per square inch (3,500 kg. per cm^2) in conventional constructions. The components are welded together into a single rigid unit by a durable high-strength phenol-formaldehyde resin, which can be applied by ordinary or high-frequency hot or cold pressing.

The new plastic bonding and masking sheets, topped by white or colored paper saturated with resin, provide an abrasion-, fatigue-, and decay-resisting surface, eliminating the periodic resurfacing and limiting the use of sterilizing and cleaning equipment necessary with painted surfaces. While up till now speeds of 4 to 10 m.p.h. have been considered collision speeds by railroad men, the end of the new car is designed to sustain impact speeds of 23 m.p.h. and in impact testings it has stood up against standard steel cars without a surface scratch.

The entire weight of the car, which is highly insulated, is 46,000 lbs. (20.4 tons). It will cost less and need fewer

skilled workers than conventional models if produced in large series. This car, if it goes into quantity production, can become a large user of plywood.

Forest Policy

Argentina

• Work has been started on the preparation of an aerial-photogrametric survey of a vast forest zone covering 160,000 hectares in the colony Manuel Belgrano, Misiones territory. This region contains important stands of Paraná pine (*Araucaria augustifolia*), considered a high-quality raw material for the production of paper pulp. This survey is a part of the newsprint project sponsored by the Government to develop the pulp and paper industries and to make the country self-sufficient in these products. The survey, by disclosing the location and volume of the forests, will be the basis for planning their exploitation, management, and proper utilization.

Japan

• The Natural Resources Section, General Headquarters, Supreme Commander for the Allied Powers in Japan, has issued comprehensive information on forest area, volume, and growth in Japan based on four years of work and designed to form a dependable basis for forest policy and practice. Although there are 39 million acres (16 million hectares) of accessible forest in Japan, only 15 percent is occupied by the coniferous timber which provides 85 percent of the sawlogs cut annually; 12 percent is occupied by broadleaved timber, which provides the remaining 15 percent of sawlogs. Thus, 73 percent of the total is made up of fuelwood forests, areas in need of reforestation, wasteland, and other nonproductive types. The seriousness of the situation is illustrated by the fact that the usable coniferous saw timber in accessible areas is only about 11,250 million cubic feet (319 million m^3 (r)), which is only 9 percent more than the coniferous volume cut during the past fifteen years. The 2,400 million cubic feet (68 million m^3 (r)) of accessible broadleaved timber and 16,000 million cubic feet (453 million m^3 (r)) of fuelwood bring the total volume to about 30,000 million cubic feet (850 million m^3 (r)), which is far too little to supply the timber and fuel needs of the people.

Average annual growth of usable saw timber is estimated at about 226 million cubic feet (6.4 million m^3 (r)), and of fuelwood, mostly hardwoods, at 445 million cubic feet (13 million m^3 (r)). Present growth is only a small fraction of that possible by intensive forest management, but the figures given represent the maximum that can safely be expected at present. There remain considerable areas of inaccessible forest, particularly of broadleaved forests. About half of the forest land is in private ownership and most of the rest in national and community ownership, with shrines and temples owning relatively small amounts; national ownership accounts for over 60 percent of the accessible saw timber volume and 51 percent of the accessible fuelwood volume.

Kenya

• Of the 220,000 square miles (570,000 km^2) of Kenya colony, only about one-third is suitable for agricultural development and normal human habitation. Except for a narrow coastal belt in the east, the remainder is hot, dry, sparsely inhabited country. But, the colony has many forest types and over 100 timber species of commercial importance. The forest types are classified into three broad groups: the mountain forests of the highlands, the semitropical rain forests of the highlands, and the lowland or coast forests.

The first group includes the Montane Rain Forest lying between 6,500 and 8,500 feet elevation (2,000 and 2,600 m.), with an average annual rainfall of 55 to 90 inches (1,400 to 2,300 mm.), and consisting of evergreen hardwoods; the Montane Conifer Forest, lying at elevations of 6,500 to 9,000 feet (2,000 to 2,700 m.) with an annual rainfall of 35 to 55 inches (900 to 1,400 mm.), and containing principally the pencil cedar (*Juniperus procera*) and two species of *Podocarpus;* the Montane Bamboo Forest, lying principally between 8,000 and 8,500 feet (2,400 and 2,600 m.); and the Montane Semi-Evergreen Forest, lying between 5,500 and 6,000 feet (1,700 and 1,800 m.) with an average annual rainfall of 35 to 40 inches (900 to 1,000 mm.).

The semitropical rain forests occur around Mount Kenya and the Lake Victoria basin at an elevation of 4,500 to 5,550 feet (1,400 to 1,700 m.), with an annual rainfall of 55 to 75 inches (1,400 to 1,900 mm.). The coast forests lie below 1,200 feet (370 m.), within a distance of 25 miles (40 km.) from the coast, and have a rainfall of 35 to 50 inches (900 to 1,300 mm.) per annum. They are subdivided into the lowland rain forest, the lowland dry forest, and the lowland savannah woodland.

Most of the supplies of *Podocarpus* have been exhausted and plantations of *Cupressus, Pinus insignis,* and *P. canariensis* have been established. Many of the Kenya timbers have close affinity with South African timbers. The weight per cubic foot of the native hardwoods ranges from 16 lbs. air-dry (256 kg. per m^3) for *Gyrocarpus asiaticus* to 75 lbs. (1,200 kg. per m^3) for *Dalbergia melanoxylon* and *Terminalia prunioides.* In the recent assembly of information on a large number of native timbers, they are classified as: very light—under 25 lbs. per cubic foot (400 kg. per m^3); light—26 to 35 lbs. (401 to 560 kg.); medium weight, 36 to 50 lbs. (561 to 801 kg.); heavy, 51 to 65 lbs. (802 to 1,041 kg.); and very heavy, over 65 lbs. (1,041 kg.). Tests of timbers in accordance with the specifications of the British Standards Institution have been made both at the Forest Products Laboratory in England and in Nairobi. For 36 of the more important species the tests are quite complete. A concordance of native and botanical names has been prepared, a complicated matter because of local variations in native names. For each of 100 species, available information has been assembled in a *Catalogue of Kenya Timbers,* giving trade and local names, size and characteristics of the tree, distribution, available supplies, characteristics of the timber, strength properties, working qualities, requirements and methods of seasoning, durability, and uses.

United Kingdom

• The Forestry Commission is offering grants to encourage the planting of poplars for timber production, either in compact blocks or in lines or avenues. Grants are payable in two forms. That for planting in blocks is £8 per acre, an advance of £4 being followed by payment of the balance after five years, if the trees have been properly established and maintained. For planting in lines or avenues the grant is two shillings per tree, with an advance of one shilling, the balance normally being payable after five years. Canker-susceptible poplars such as the balsam group of species and hybrids, and a limited number of other species, do not qualify for grants.

Much of the poplar used for matchmaking is imported. This wood is also used for the manufacture of chip baskets, for the packing of fruit, and for packing cases and paper pulp.

United States of America

• In August 1948 a preliminary award of 1,500 million cubic feet (42 million m^3) of Alaskan pulp timber was made by the Chief of the Forest Service, under which the company receiving the award was required to meet certain qualifications for final purchase of the timber. The date for the final award has been extended for two years so that additional time will be available to complete plans for construction of a sulphite pulp-mill using the magnesium base process, since difficulties in applying the process on a commercial scale makes it impracticable for the company to complete the final design now. This process eliminates all possibility that pulp-mill waste material might pollute ocean water and damage the fishing industry. The initial mill will have a daily capacity of 300 tons of pulp. The 1,500 million cubic feet of timber will supply a pulp-mill with a daily capacity of 525 tons for fifty years.

• One of the important pieces of recent Federal legislation is the Anderson-Mansfield Act, intended to accelerate and provide a continuous basis for reforestation and revegetation of national forest lands and other lands under the administration of the Forest Service. Appropriations are authorized in progressively increasing amounts for reforestation, ranging from $3 million for fiscal year 1951 to $10 million for 1955, and a like amount each year thereafter through 1965. Similarly, appropriations are authorized for range revegetation, beginning with $1.5 million for 1951 and increasing gradually each year up to $3 million in 1955, and a like amount thereafter through 1965. The lands affected are the sole or main source of summer range for 10 million cattle and sheep grazed by 30,000 livestock permittees. They include over 4 million acres (1.6 million hectares) of denuded and unsatisfactorily stocked timber lands and an additional 4 million acres of seriously depleted range lands.

Also noteworthy were the amendments to the Clarke-McNary Act of 1924. The

appropriation authorization for co-operative forest fire protection was increased from $9 million to $20 million in gradual steps through the year 1955. Authorization for expenditures in the production and distribution of forest planting stock to private landowners, in co-operation with the states, was increased from $100,000 to $2.5 million annually. Not more than $1 million was authorized for fiscal 1950, but there is provision for an increase of $500,000 each year through 1952, when a maximum of $2.5 million is to be reached. Authorization for educational work, in co-operation with the states, land grant colleges, and other suitable state agencies, as an aid to farm forest owners, was increased from $100,000 to $500,000 annually.

During the year, legislation provided for an increase in the authorization for initial forest surveys from $6.5 million to $11 million; and for an increase in the authorization for resurveys from $250,000 to $1.5 million annually.

The most important forest law enacted by any of the states in 1949 was one relating to forest conservation and taxation in New Hampshire. Its purpose is to encourage forest conservation by exempting the timber on forest land from the yearly burden of local property taxes and substituting a yield tax of 10 percent on wood and timber at the time of cutting. Of particular interest is a clause of the act which provides for a 30 percent abatement of the yield tax if the forest owner uses approved forest practices.

Reviews

It is the policy of FAO to review here selected publications which appear to have a direct bearing on the current work of the Forestry and Forest Products Division.

Waldbau auf Pflanzengeographisch-Ökologischer Grundlage. (Silviculture Based on Plant Geography and Ecology.) Leo Tschermak. Pp. xiv + 722, with 153 drawings and tables. Springer-Verlag, Vienna, Austria. 1950. $14.50.

This is a comprehensive study of the relation between forests and their environment as a basis for silvicultural practices. It is only through understanding of this relationship that a lasting and effective forest management is possible. It means working with nature and not against nature. It means a thorough knowledge of the natural geographic range of the species, their rainfall, heat and light requirements, their suitability to the soils and all other environment factors which in their totality create the biological conditions for the existence, growth and development of forests. Since these conditions vary from country to country, the silvicultural practices must also vary. Professor Tschermak does not claim to be the innovator of the biological approach to silviculture.

For the last few decades there have appeared many textbooks in different countries expressing the same point of view. In 1937, Professor Toumey, in the United States, stressed the ecological basis as the foundation of silviculture; in 1928, Professor G. F. Murozov, in Russia, analyzed the forest as a geographic phenomenon. In 1938, Professor A. Pavari, in Italy, advanced the same views. In Germany two classical works on the subject have been published: one by K. Rubner, in 1934, and another by A. Dengler in 1944. What distinguishes Tschermak's work from those of his predecessors is that his study is confined to the mountainous forests of Central and Southern Europe, with special reference to the forests of Austria and its neighboring countries, the Balkan Peninsula and Turkey.

The book is divided into two parts. Part I deals with the basic plant geographic facts such as the influence of heat, water, light, content of carbon dioxide in the air, wind, soil, and all other environmental conditions upon the occurrence and growth of certain forests and tree species. It contains a description of the forest regions of Austria, Germany, the Balkan Peninsula, and Turkey. A chapter is devoted to the effect of the animal world upon forest vegetation, which is far from insignificant and seldom receives the attention it deserves. Part II—The Techniques of Silviculture—is devoted to the application of the biological principles to the silvicultural treatment of definite stands and species. There is a wealth of detailed information about forest types and species of which little was known before. Thus Professor Tschermak's work is a significant contribution to both forest ecology as a scientific discipline and practical silviculture, especially in some still little known regions.

Harvesting Timber Crops. A. E. Wackerman. Pp. 437, illus. McGraw-Hill Book Company, Inc., New York. 1949. $5.00.

The principles and methods developed to harvest timber in the United States of America are of interest to other countries which are changing over to mechanized power, or which face decisions on the most efficient methods to use in forests which are to be exploited for the first time. The forests in the United States vary from small scattered patches to enormous solid stands, from light to very heavy stands per unit of area, from small to giant trees; they are found on level ground and on steep hills, and they grow on soil ranging from sandy to very rocky. Thus the variety of problems is very great.

Methods of meeting these problems are still under experiment, and a vast amount of technical literature describes this or that device, machine, operation, or layout; but the very wealth of published material makes it difficult to select those methods best suited to particular sets of conditions.

The author of this latest addition to the American Forestry Series of textbooks has brought together a summary of the information available. In Part I, "Considerations Preliminary to Actual Harvesting," he treats in separate chapters of timber crops—the goal of foresters, the development of forest industries in America, the origins of modern timber-harvesting methods, planning the timber harvest, and forest labor. The necessity for intelligent planning to adapt methods for each step to the problems set by the forest and ground and to combine the separate steps into an efficient and balanced operation is well explained. Erroneous selections and combinations may lead to inefficient and wasteful harvesting from the standpoint of costs and returns and to needless damage or destruction of the forests. Operations succeed or fail as the available labor is efficiently organized and trained for the methods which are to be used. Labor efficiency will be greatly affected by the ways in which men are housed and fed, and by the correct relationship of camps to the forest operations.

In Part II, "Preparation of Trees for Removal from the Forest," chapters cover selection of trees to cut, the felling operation, bucking felled trees, hewing, riving, and peeling, and tools used in felling, bucking, and processing trees. Here the relationship of utilization to forestry is treated in some detail. The most modern power saws of various types which have proven effective are sufficiently described, and the best patterns of a large number of hand tools such as axes, saws, etc., are also dealt with.

Part III, "Movement of Products from the Forest," separately considers bunching products in the forest, skidding, loading, and transportation from the forest. Here a very large number of mechanical devices have been developed to meet the problems encountered in forests of different kinds.

Part IV, "Organization and Control of Harvesting Operations," deals with the measurement of forest products, organization of harvesting operations, costs and records, and regional harvesting practices. The methods of measurement represent United States practice and cover logs, pulpwood bolts, stacked or ricked products, piece products such as poles, piles, and ties, and the converting factors commonly in practice. The major factors to be considered in operations include the types of ground and weather conditions to be expected, whether the operation will be seasonal or year-round, the average daily or seasonal output sought, and the general type of operation decided upon to meet conditions. Thus small-scale operations differ greatly from large-scale operations, and the latter vary depending upon whether they are concentrated or scattered. The for-

est owner who does his own utilization may organize differently than other types. Proper records of costs are a necessary step in controlling harvesting costs and returns, and methods for proper cost keeping are described.

Finally, in a series of papers by qualified experts, the harvesting practices in the principal forest regions of the United States are described and related to the local forestry problems. In emphasizing principles, and in relating harvesting methods to forestry, the author has performed a useful service not only to United States foresters but also to foresters in many other countries.

Out of the Earth. Louis Bromfield, Pp. 305, illus. Harper and Bros., New York. 1950. $4.00.

Some years ago the author acquired an area of badly run-down farm land in Ohio—eroded, poorly drained, lacking organic material in the soil, and producing low and uncertain yields. The original forests were long since gone, and repeated cropping to maize had apparently "worn out" the soil. He started to build up the soil and the yields, making each step pay its own way, and using a system based on the vast array of technical studies available. Finally he succeeded in demonstrating that intelligent farming—the new agriculture—could stand on its own feet without aids, subsidies, and subventions.

The author kept detailed records of operations and their results, costs, and incomes. An articulate man, he has set forth the results in three books, together with his personal philosophy. Fascinated with the experience, he has encouraged visitors to come, to see, and to learn; thousands from the U.S.A. and many other lands have come. In this, the third volume, he has set down what has happened, why and how it happened, and how similar results can be obtained on other farms.

Essentially, and in oversimplified form, what has been done is to restore forest or permanent grass to rough or steep land unsuited for plowing, to restore organic material to the soil by growing and turning under cover crops, to restore needed chemicals in the topsoil by using deep-rooted alfalfa to tap the reserves in deep soil layers, and to rotate crops. This involved a shift from maize and other grains to grasses, legumes, and livestock. But Mr. Bromfield has used chemical fertilizers and soil conditioners to supplement the organic farming. The full story, of course, involves much detail, but the way it is told, and the explanations of why and how, engross the reader throughout the whole narrative.

This is a story of how productive and profitable agriculture can be restored on sloping lands that were formerly in forest, a story of the resources of science intelligently and energetically applied. Foresters should find it interesting not alone for what it tells but as a challenge to the doctrine that restoration to forest is the prime remedy for rundown cropland. Much experience is needed in other areas and countries before the conflicting claims of foresters and farmers for use of land can be worked out on a rational basis, with each use in its proper place and both uses conserving the soil and the water. This book is a step toward that goal.

El Castano en Espana. J. Elorrieta y Artaza. Pp. 303, illus. Ministerio de Agricultura, Instituto Forestal de Investigaciones y Experiencias, Madrid, Spain. 1949.

Th author discusses botanical aspects of *Castanea sativa,* including its most important varieties in Galicia and the Basque province. Among the principal characteristics of this tree are its calcifobia and humidity requirements, both of soil and atmosphere, in the different localities, which are characterized by the most varied plant associations.

The second part of the book is devoted to silvicultural aspects describing in detail the forests exploited as high forest and coppice, the latter providing hoop and stave material for cooperage. The most convenient rotation systems are discussed from silvicultural and economic points of view. Special mention is made of the pollarded forests in Galicia and artificial regeneration, detailing the different methods of sowing and planting, nursery work, and seed selection.

A description is given of the *castañarejos,* forests exploited for their nuts, with full details as to culture, grafting, fruit production, and regeneration.

The most important uses of timber and fruit are given with special mention of stave fabrication and the different kinds of packing used in Andalusia and Catalonia.

The last part of the book deals with pathology, with special reference to the two principal chestnut diseases—ink disease, caused by the fungus *Phytophthora cambivora,* and the blight caused by *Endothia parasitica.* Considering the great damage caused by these two pests, they are discussed in detail. A plan is presented for the control of these diseases and for Spanish reafforestation, taking into account the latest experience obtained by breeding and crossing the common chestnut with the Chinese chestnut (*C. mollissima*) and the Japanese chestnut (*C. crenata*), both of which are resistant to these diseases.

Direito Florestal Brasileiro. (Brazilian Forest Legislation.) Osny Duarte Pereira, Federal District Judge. Borsoi, Rio de Janeiro. 1950.

At the request of the National Pine Institute, and with its assistance, the author undertook this definitive study of forest legislation, which extends its scope beyond Brazilian law.

The introduction by the President of the Institute and the words of praise by the Federal Director of Forests and the Federal Forestry Council show that they consider this work one of great value and significance.

The first chapters are serious comparative studies of forest legislation: the origins of forest law and modern forest legislation in most countries of the world. There follows a study of the historical development of Brazilian forest legislation during the Colonial and Republican periods, with a summary of the legislation of the major states belonging to the Federation.

The author then discusses the economic foundations and purposes of forest legislation and follows with a series of studies of such legislation in relation to the climatic, ecological, economic, and political background of various countries, including Brazil. Finally, he deals with special aspects of this legislation (infractions of forest laws, forest fires, punishment of infractions, and forest police services), and the organization of forest services (the forestry fund, the Federal Forestry Council, the Forest Service of the Ministry of Agriculture, and the Pine Institute.) The book concludes with a complete bibliography.

This work, the first of its kind in Latin America, has a definite place in the library of foresters and jurists.

The Rural Economy of New England. John Donald Black. Pp. 796; 123 tables, 155 charts. Harvard University Press, Cambridge, Massachusetts, U.S.A. 1950. $7.50.

This study concerns the economy of the six New England states—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. This research on a regional economy is focused on the subject of soil use and is written from the rural viewpoint.

The income from New England woodlands in their present condition and under the generally nonscientific management which they now receive, can be estimated to be only about $60 million annually, as compared with the $250 million obtained from farm crops. However, in contrast with too many rural economists, the author makes a detailed study of the forest resource, which covers 12.4 million hectares or three-quarters of the area, and plays a basic protective role in preventing soil erosion and regulating stream flow.

Although forestry is discussed incidentally throughout the book, foresters will read with particular interest the chapter on woodlands and their management. Stressing small forest holdings and farm forests particularly, which are generally badly managed, the author seeks to discover how this situation can be remedied. The economic importance of this question is indicated by a census of 1945, which disclosed that there are more than 4,300 "forest products farms" in New England—those which derive a higher income from the forest than from all other crops put together.

Particularly thought-provoking is the study of a Maine family farm in which forestry and dairy production are combined. The author concludes that a farm consisting of 120 hectares of woodland and 20 hectares of cultivated land, with sufficient pasture for the maintenance of 10 milk cows, could—if the forests were put under intensive management—readily yield a revenue comparable to that of the usual dairy farm in Maine.

No less significant is the study on forest co-operatives. These organizations were formed to encourage the scientific management of forests and to market the produce from small properties. Unfortunately, they were established in New England only a few years before World War II, then the rise in timber prices led their members to trade individually rather than collectively with buyers ready to offer high prices. However, the author considers co-operatives the most rational solution of the problem of small private forests in this region.

Fifty Years of Forestry in the U.S.A. Robert K. Winters, Editor. Pp. 385, illus. Society of American Foresters, Washington 6, D. C., U.S.A. 1950. $4.00.

In 1898 there were only two native-born, professionally trained foresters in the United States of America, and two who were European born and trained. There were no professional schools, no textbooks, and practically no technical facts directly applicable to the varied and complex forests of the country. Fifty years later there were about 15,000 trained foresters, 22 accredited professional schools of forestry and a vast and growing body of technical knowledge dealing with the forests and forestry.

The Society of American Foresters was founded on 30 November 1900 by seven men. In 1945 it was decided to prepare a history of forestry in the United States for the half-century which had passed since the founding of the Society. This volume is the result of the work of the Society's committee and of the 19 authors selected to prepare chapters on important phases of forestry and on organizations and activities that have contributed to the advancement of professional forestry. Robert K. Winters served as chairman of the committee, editor of the history, and author of the initial chapter summarizing professional growth and achievement during the first half-century. He has thus contributed greatly to a notable volume, a worthy memorial to the 50th anniversary of the Society. It is fitting that the work should be done by the Society which brings together generalists and specialists; administrators and researchers; employees of federal, state, and local governments and of international and private organizations; foresters who deal with timber-growing and timber utilization, with range, forest wild life and forest recreation, and with forest influences and farm forestry; as well as teachers in professional schools and workers in public education.

The impact of these varied interests, one on the other, makes the Society today a true forum where many-sided forestry and forest problems may be debated both from technical and public policy viewpoints.

During the half-century, progress in technical foundation and in practice have not been equal in their several phases. The authors have added to the historical record a critique of present status and a forecast. For example, in protection against fire the losses have been reduced to about one-eighth of those of 40 years ago, and new methods are being developed rapidly; but local catastrophes still occur and there is no organized protection for roughly 130 million acres of forest. There is, however, confidence in continuing progress. Protection against diseases and insects has been less effective, but the development of new weapons and the gradual shift from direct control to silviculture improve the outlook for progress. Silviculture has changed from a theoretical to a more practical basis, adapted to the forests. Intensive and sustained-yield management are still far from general. Forest utilization has improved greatly in several ways, including an increase in integrated operations. Range management is growing into a science, but application of available management practices is still far from general.

This is a sober and thoughtful piece of work. It recognizes mistakes and deficiencies as well as successes and achievements. The job of the profession is far from complete. But the progress made and position attained form a solid basis for reasoned optimism that with continuing energy, daring, and imagination, forestry in the United States of America may accelerate its advance to a pace fully geared to the needs and necessities of the nation and the world. Since the book is far more than an historical reference text, it is to be hoped that many foresters in many lands will wish to read it in full.

Water, Land, and People. Bernard Frank and Anthony Netboy. Pp. 331, illus. Alfred A. Knopf, Inc., New York 22, N. Y. 1950. $4.00.

That all is not well with the water and land resources of the United States of America is well known. Many surveys and studies have assembled facts about floods, droughts, near-failures of domestic water supplies, erosion, dust storms, silting of reservoirs and stream-channels, lasting damage to forest and range lands, and the other familiar consequences of land abuse. The proximate causes of troubles have been fully and eloquently described and denounced. Havoc and ruin have been predicted. Remedies have been tried on varying scales and new courses of organized public action are even now under study.

The experience of the United States, its present situation and its prospects, are important not only to itself, but to other nations as well where similar problems are foreseeable, for the variety and magnitude of problems and the number and complexity of attempted or proposed solutions in the United States are nearly encyclopedic in coverage.

The first thing to do—and that is the authors' approach—is to grasp the essential but often ignored fact that several manifestations of trouble are not separate but are interrelated aspects of a single problem. Next, in a book addressed to intelligent laymen, it is necessary to explain rationally how and why use or abuse of land of different sorts, under different combinations of soil, topography and climate, results in changes of the biological community and of the soil itself and thus in the behavior of water. These causes and effects are comprehensible when soundly and simply explained.

But it is to the solutions that the authors address most of the book. Those tried to date are of three categories: engineering works, control of land use and river-basin development — TVA. Great dams alter the habit of the main stream and of tributaries as well, building up stream bed levels, and where the inevitable levees go in, the problem is still unsolved. As reservoir capacity is lost through siltation, attention turns to an endless and enormously costly upstream reservoir system—still no permanent solution. And flooding river bottoms by reservoirs displaces people and communities that the engineering programs are designed to protect, and destroys notable and irreplaceable scenic and recreation areas. High dams will probably destroy the great runs of salmon on west coast streams. Of course dams are necessary and useful, but they emphatically are not a full answer to land and water problems.

Land use has developed by trial and error and with general freedom to exploit. A notable success in attaining sound use has been worked out on the national forests, but the public programs of co-operation are having a solid beneficial effect on many but not all private forest lands. The soil conservation district program is good, but far from all the land needing conservation is organized, and local districts are extremely reluctant to adopt stringent measures of self-regulation, even when they are genuinely needed. Subsidy payments are made for conservation practices on farm lands, but supervision and inspection are incomplete and co-ordination of programs is far from perfect. The programs on the vast area of public range lands and Indian reservations move at a snail's pace compared to the needs.

The most comprehensive program is the U. S. Department of Agriculture upstream flood control program, begun in the middle 'thirties. Whole watersheds are surveyed, programs of remedial action are worked out with effective local participation, and then applied over a generally long period, and both land use and engineering practices are used. But the pace of action lags far behind surveys and plans.

Better private land use depends almost wholly on voluntary action by landowners, since to date it has proved politically impossible to obtain such real controls of use as regulation of timber cutting and plowing of hill lands or unstable soils. And federal and state appropriations for land use programs are pathetically small in relation to needs and in comparison with vast expenditures for engineering works.

Finally, the authors say "Now is the time." If effective remedial programs on a comprehensive scale are to come into being several things are necessary. Greater knowledge of conditions, problems, and remedial practices is needed. Public apathy and ignorance, now the main obstacles to greater progress, must be overcome. Land use must be publicly controlled to prevent abuses and to serve the general welfare. Private land of critical importance should go into public ownership. Some sort of over-all planning and review board is urgently needed to control the unco-ordinated programs of the many agencies concerned. The ultimate test is whether the country can alter established cultural patterns sufficiently and rapidly.

By using selected case histories to illustrate their main points, the authors successfully focus attention on whole problems and emphasize the many aspects which need to be dealt with concurrently. The book is written with deep conviction as well as with great knowledge and understanding. Above all, it avoids the alluring pitfalls of overstatement, of single-track commitment to one course of action against all others, and of criticism without proper documentation.

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